COSEWIC
Assessment and Status Report

on the

Audouin's Night-stalking Tiger Beetle
Omus audouini

in Canada

THREATENED
2013

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

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COSEWIC would like to acknowledge Jennifer Heron for writing the status report on the Audouin's Night-stalking Tiger Beetle, *Omus audouini*, in Canada, prepared under contract with Environment Canada. This report was overseen and edited by Dr. Paul Catling, Co-chair of the COSEWIC Arthropods Specialist Subcommittee and Sydney G. Cannings, COSEWIC member from the Canadian Wildlife Service.

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Audouin's Night-stalking Tiger Beetle — Photograph by Andy Teucher.

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COSEWIC
Assessment Summary

Assessment Summary – November 2013

Common name
Audouin's Night-stalking Tiger Beetle

Scientific name
Omus audouini

Status
Threatened

Reason for designation
This beetle is restricted to a small area in the Georgia Basin of southwestern British Columbia, within a narrow strip of coastal lowland around Boundary Bay and Greater Victoria. Major threats include habitat loss through agricultural and urban development, vegetation succession in open habitats, disturbance from recreational activities, and, in the longer term, sea level rise. There are fewer than ten known sites, and the discovery of more populations is unlikely. The species is flightless and thus dispersal is limited.

Occurrence
British Columbia

Status history
Designated Threatened in November 2013.

COSEWIC
Executive Summary

Audouin's Night-stalking Tiger Beetle
Omus audouini

Wildlife Species Description and Significance

The Audouin's Night-stalking Tiger Beetle is a medium sized (14 – 18 mm), dull black, flightless beetle. A closely related species, the Greater Night-stalking Tiger Beetle, occurs in similar habitats, but the adults of both species are easily distinguished.

Distribution

The global range of the Audouin's Night-stalking Tiger Beetle is in western North America from the southwestern corner of B.C. south through western Washington and Oregon to northwestern California. Approximately 10% of the global range is in Canada. Within Canada, the species is restricted to a small area of the Georgia Basin, with sites recorded from a thin strip of coastal lowland habitat in the Boundary Bay area (mainland) and the greater Victoria area (Vancouver Island). Overall, there are eleven recorded sites within Canada (extant and extirpated). Nine of these sites are considered extant: seven in the Lower Mainland and two in greater Victoria. Three of the nine sites are unconfirmed but potential habitat is still present within the general collection areas and these are considered extant. The two sites considered extirpated are both in the greater Victoria area and in regions with extensive (1960s to present) urban development. The Canadian range extent is estimated at 1600 km^2 and all but one site is within 1 km of the marine shoreline (that site is within 3 km).

Habitat

The Audouin's Night-stalking Tiger Beetle inhabits low elevation coastal terrain. All sites in B.C. are less than 20 m above sea level and within 3 km of the saltwater shoreline. Adults are ground crawlers, heat lovers, and wanderers in forest meadow margins and areas that consist of open, sunny sites.

The Audouin's Night-stalking Tiger Beetle is recorded from two ecosystem types in B.C.: 1) sparsely vegetated sand ecosystems (six of the nine extant sites) and 2) Garry Oak and associated ecosystems (three extant sites and two extirpated sites, although extirpated site collection information is vague and habitat is inferred). Overall habitat description includes open grassy areas, sparsely vegetated habitats, coastal bluffs, meadows, open forests, older agricultural fields (no crops present for a number of years), and similar habitats.

Larvae dwell in underground burrows, typically located within clay banks with up to 50% slope, and usually above the ocean high-tide line. Burrows are frequently adjacent to hiking trails and within road cuts, stream banks and other similar habitats.

The Audouin's Night-stalking Tiger Beetle appears to be tolerant of some forms of habitat disturbance, although it does not appear to depend on dynamic environmental factors such as fire or flooding. All known sites are from areas potentially flooded by seawater or periodic freshwater floods due to rain runoff. Six sites are within high recreation habitats and all have both non-native (alien) and native (natural succession) invasive species.

Biology

The Audouin's Night-stalking Tiger Beetle has four main life stages: egg, larva (three larval instars), pupa and adult. Only adult beetles have been observed in B.C. They mate sometime in the early spring, and females lay 10 – 20 eggs per day within suitable substrate for larval burrow construction, and egg-laying continues throughout early spring. Depending on the species and local temperature conditions, tiger beetle eggs hatch 9 to 38 days later.

Tiger beetles spend from 1 to 3 years in the larval stage, during which time they excavate long, deep and narrow cylindrical tunnels (20 – 35 cm) and develop through three instars. Larvae close their tunnels during winter months. Pupation takes place after the third larval instar within a chamber at the bottom of the larval burrow. Adults and larvae are voracious opportunistic predators and feed on a variety of small arthropods, including ants and centipedes. Adults are mobile, crawling around at moderate speeds and moving like a spider. Larvae are sit-and-wait predators, being predominantly confined to their burrow.

Population Sizes and Trends

The Audouin's Night-stalking Tiger Beetle has not been studied at a population level. Surveys have been by pitfall trapping and hand searching, methods that do not give population estimates. There are insufficient data to provide an accurate estimate of abundance across the species' Canadian range. Most specimen and sight record data are of single individuals. The species is flightless, and although it is considered to have moderate running ability, it is unlikely that it could significantly disperse through terrestrial habitats.

Threats and Limiting Factors

Primary threats include habitat loss through agricultural and urban development, ongoing pesticide use in some areas, vegetation succession in sparsely-vegetated habitats, disturbance from recreational activities, storm surges and, in the longer term, sea level rise.

Protection, Status, and Ranks

The Audouin's Night-stalking Tiger Beetle is not currently protected by provincial or federal laws. The species is Red-listed (critically imperiled) by the British Columbia Conservation Data Centre and ranked globally secure by NatureServe.

TECHNICAL SUMMARY

Omus audouini
Audouin's Night-stalking Tiger Beetle Cicindèle d'Audouin
Range of occurrence in Canada: British Columbia

Demographic Information

Generation time	2-3 yrs
Is there an inferred continuing decline in number of mature individuals?	Inferred, based on habitat loss and degradation of known sites
Estimated percent of continuing decline in total number of mature individuals within 5 years	Not applicable
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].	Not applicable
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Not applicable
[Observed, estimated, inferred, or suspected] percent [reduction] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future.	Inferred reduction in total number of mature individuals based on habitat loss and degradation of known sites
Are the causes of the decline clearly reversible and understood and ceased?	Not reversible (habitat loss and degradation); partially understood; not ceased.
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence • Inclusive of sites on Vancouver Island and Lower Mainland, including the Georgia Strait waterway.	1600 km²
Index of area of occupancy (IAO) (Always report 2x2 grid value). 36 km² including all nine sites (historic and extant); 24 km² including known extant sites	24 km²
Is the population severely fragmented?	No
Number of locations* (based on the threat of land development).	9
Is there an [inferred] continuing decline in extent of occurrence?	No
Is there an [inferred] continuing decline in index of area of occupancy?	No
Is there an [inferred] continuing decline in number of populations?	No
Is there an [inferred] continuing decline in number of locations*?	No

Is there an [inferred] continuing decline in [area, extent and/or quality] of habitat?	Yes. Inferred decline based on threats (primarily urban and suburban development, invasive species, increased winter storm surges, and recreational impacts).
Are there extreme fluctuations in number of populations?	No
Are there extreme fluctuations in number of locations*?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of Mature Individuals (in each population)

Population	N Mature Individuals
Total	unknown

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	N/A

Threats (actual or imminent, to populations or habitats)

Major threats include habitat loss through agricultural and urban development, ongoing pesticide use in some areas, vegetation succession in open habitats, disturbance from recreational activities, storm surges and, in the longer term, sea level rise.

Rescue Effect (immigration from outside Canada)

Status of outside population(s)? WA, OR: S5; CA: not ranked	Secure
Is immigration known or possible?	Not possible
Would immigrants be adapted to survive in Canada?	Yes, likely.
Is there sufficient habitat for immigrants in Canada?	Yes
Is rescue from outside populations likely?	No

Data Sensitive Species

Is this a data sensitive species?	No

Status History

COSEWIC: Designated Threatened in November 2013.

Status and Reasons for Designation:

Status:	Alpha-numeric code:
Threatened	B1ab(iii)+2ab(iii)

Reasons for designation:
This beetle is restricted to a small area in the Georgia Basin of southwestern British Columbia, within a narrow strip of coastal lowland around Boundary Bay and Greater Victoria. Major threats include habitat loss through agricultural and urban development, vegetation succession in open habitats, disturbance from recreational activities, and, in the longer term, sea level rise. There are fewer than ten known sites, and the discovery of more populations is unlikely. The species is flightless and thus dispersal is limited.

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Does not meet these criteria. Population estimates and trends unavailable.
Criterion B (Small Distribution Range and Decline or Fluctuation): Meets Threatened B1ab(iii)+2ab(iii) because the EO and IAO are below the thresholds, there are fewer than 10 locations and there are continuing declines in the area, extent and quality of habitat. Insufficient information to support severely fragmented.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. Population estimates and trends unknown.
Criterion D (Very Small or Restricted Population): Not applicable. Number of mature individuals is unknown, there are more than 5 locations and IAO is greater than 20km^2.
Criterion E (Quantitative Analysis): Not performed.

COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS
(2013)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.

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Canada

The Canadian Wildlife Service, Environment Canada, provides full administrative and financial support to the COSEWIC Secretariat.

COSEWIC Status Report

on the

Audouin's Night-stalking Tiger Beetle

Omus audouini

in Canada

2013

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Figure 4. Search effort for the Audouin's Night-stalking Tiger Beetle. Pitfall trap sites are represented as small black dots. Pitfall trapping within southwestern B.C. from 1989 - 2012 amounts to a minimum of 722 sites and more than 73,000 trap nights (124 sites on Vancouver Island, 95 sites on southern Gulf Islands, 96 sites on the Sunshine Coast and 406 sites in the Lower Fraser Valley). Numerous traps are sometimes represented by one dot on the map. Specimen records for *Omus dejeani* (the Greater Night-stalking Tiger Beetle) are another measure of search effort for this species. Map created by Orville Dyer (B.C. Ministry of Forests, Lands and Resource Operations) September 20, 2013. 12

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Table 5. Threats to Audouin's Night-stalking Tiger Beetle sites. Sites with * have vague collection information, applicable threats apply to potential sites within this general region. 37

WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Scientific Name: *Omus audouini* Reiche 1838

Classification:

Kingdom	Animalia
Phylum	Mandibulata
Class	Insecta
Order	Coleoptera (beetles)
Family	Carabidae (Ground)
Subfamily	Cicindelinae Latreille 1802 (Tiger Beetles)
Tribe	Megacephalini Laporte 1834
Genus	*Omus* Eschscholtz 1829
Species	*Omus audouini* Reiche 1838

Synonyms:

Omus ambiguus Schaupp 1884
Omus audouini vandykei Horn 1903
Omus borealis Casey 1909
Omus californicus humeroplanatus Horn 1910
Omus audouini parvulus Casey 1913
Omus oregonensis Casey 1913
Omus rugipennis Casey 1914
Omus solidulus Casey 1914
Omus audouini brevicornis Casey 1916
Omus audouini aequicornis Casey 1916
Omus audouini tacomae Casey 1916
Omus audouini delicatulus Casey 1916
Omus audouini distans Casey 1916
Omus ambiguus humeralis 1916
Omus thoracicus Casey 1916
Omus cephalicus audens Casey 1924
Omus ambiguous socius Casey 1924

English Names: Audouin's Night-stalking Tiger Beetle

French Names: Cicindèle d'Audouin

Taxonomic Background and Similarities: The Audouin's Night-stalking Tiger Beetle (*Omus audouini*) is currently placed within the Family Carabidae, Subfamily Cicindelinae (tiger beetles). However, the taxonomic hierarchy of this group is not settled and no universally accepted placement of the group exists. Traditionally, tiger beetles have been classified within their own family Cicindelidae, but more recently have been grouped as subfamily Cicindelinae within the family Carabidae. Some experts also place tiger beetles within the subfamily Carabinae.

Tiger beetle classification was first published by Horn (1915) and revised by Rivalier (1954) based on genitalic characters (Pearson *et al.* 2006). The systematics of genus *Omus* is poorly studied in North America, primarily due to the lack of distinguishing morphological characters. Experts believe there are 5 to 15 species and an indeterminate number of subspecies within the genus in North America (Pearson *et al.* 2005). More specifically, there are fifteen species or subspecies of *Omus audouini* or *O. californicus* (synonym), distinguished primarily by geographic location (Pearson *et al.* 2005). There is only one form of the Audouin's Night-stalking Tiger Beetle in B.C.

Two *Omus* species range in B.C.: Audouin's Night-stalking Tiger Beetle and Greater Night-stalking Tiger Beetle (*Omus dejeani*). Both species are easily identified and separated by morphological characters (Maser 1977b) (see Morphological Description), and there is no taxonomic debate concerning their separation (Pearson *et al.* 2005).

Morphological Description

Tiger beetles have four life stages: adult, larva, pupa and egg. Audouin's Night-stalking Tiger Beetle adults (Figure 1) are medium-sized (14 – 18 mm), dull black, flightless and non-gregarious. Adult *Omus* are distinguished from other ground beetles by their hind legs and unmodified, filiform (thread-like) and 11-segmented antennae (antennal segments longer than wide). Antennae are attached along the upper edge of the clypeus (upper 'lip') at the front of the head, which extends laterally beyond the antennal attachment area. *Omus* have large, distinct, sickle-shaped and toothed mandibles that distinguish this genus from other ground beetles in the family Carabidae. The eyes are slightly longer than the pronotum and long hairs line the inner eye edges. The elytra are punctate (dimpled). The number of abdominal segments distinguishes sexes: seven abdominal segments in males and five in females (Comstock 1920). Adults have long legs, and the hind leg segment closest to their body (coxa) is fused to the thorax and divides the first abdominal segment on the beetle's underside.

Figure 1. Adult Audouin's Night-stalking Tiger Beetle, Saanich, B.C. Observed April 27, 2012 at Lochside Trail, just south of the intersection with Vernon Avenue. Weather was cloudy, light rain and 10°C. Specimen deposited at Royal British Columbia Museum, Victoria, B.C. Photograph by Andy Teucher.

Greater Night-stalking Tiger Beetle adults are similar in appearance although slightly larger (18 – 21 mm), without dimpled elytra and with a thinner thorax and abdomen (Maser 1977b; Pearson *et al.* 2005). Other ground-dwelling and flightless carabids are abundant throughout the same habitats as the Audouin's Night-stalking Tiger Beetle, but all these lack the sickle-shaped mandibles present in the genus *Omus*.

Tiger beetle larvae (15 – 22 mm) are S-shaped, solitary, sedentary, grub-like, predatory, sit-and-wait soil burrowers that dig a deep tunnel within which they spend up to three years. All tiger beetle larvae have three stout bristles directly above the eyes (Dimmock and Mann 1879). *Omus* larvae have 3 pairs of curved-hook spines on the 5th abdominal segment hump (other tiger beetle larvae have 2 pairs of spines on the 5th abdominal segment hump) (Hamilton 1925; Pearson *et al.* 2005). Audouin's Night-stalking Tiger Beetle larvae were first described by Hamilton (1925) and later revised by Leffler (1979, 1985). In summary, larvae have a shiny black head with greenish-brassy and violet metallic reflections; the pronotum (portion of body closest to the head) is brownish-black, gradually becoming yellowish-brown towards the posterior of the body. Sclerotized (hardened) areas (e.g., legs, setae) are dark brown. Larvae lie with their head and mandibles plugging the burrow entrance, and are first noticed when disturbed and subsequently retreat deeper into their burrow and a small dark hole appears in the soil substrate.

Omus larvae have three instars (L1, L2, L3), each instar distinguished by the increase in number of setae on the mesal edge of the basal segment of the maxillary galea (L1 – one setae, L2 – 2 setae, L3 – 3 setae) (Leffler 1985). Larvae of the Greater Night-stalking Tiger Beetle and the Audouin's Night-stalking Tiger Beetle are difficult to distinguish without following a key (see Leffler 1979).

Population Spatial Structure and Variability

No studies on population spatial structure and variability have been completed for the Audouin's Night-stalking Tiger Beetle in B.C. or elsewhere within its global range. Its mitochondrial DNA has not been sequenced (International Barcode of Life Project 2012).

Designatable Units

The Audouin's Night-stalking Tiger Beetle has one designatable unit within Canada. The species occurs entirely in the COSEWIC (2011) Pacific National Ecological Area and there is no information on population genetic structure among sites. There also are no data on discreteness or evolutionary significance among populations.

Special Significance

The Audouin's Night-stalking Tiger Beetle is a large and conspicuous yet poorly known species recorded from southern coastal sparsely vegetated sand ecosystems of the Georgia Strait and the rare Garry Oak ecosystems of southern Vancouver Island. Both these ecosystems are rare in the province and hold significant conservation value. The Audouin's Night-stalking Tiger Beetle is of interest to entomologists because of its apparent rarity throughout these ecosystems. Tiger beetles (in general) are used as indicator species in ecological studies on biodiversity (Pearson and Cassola 1992). Tiger beetles are also of interest to entomologists and naturalists because of their usually bright colour patterns and their diurnal hunting habits (Acorn 2001).

There is no information that suggests the beetle has an important cultural or economic role for First Nations people in the region. However, there is some literature on the cultural significance of plants associated with some of the habitats in which the Audouin's Night-stalking Tiger Beetle occurs. For example, there is extensive literature on the cultural significance of Garry Oak ecosystems, the plants within these ecosystems, and their importance to First Nations people (summarized in Fuchs 2000).

In addition to the Audouin's Night-stalking Tiger Beetle, approximately 464 provincially listed (Red or Blue-listed) species at risk inhabit the coastal lowlands of southeastern Vancouver Island and the Lower Fraser Valley and more than 155 of these species have been assessed by COSEWIC (COSEWIC 2012).

DISTRIBUTION

Global Range

The Audouin's Night-stalking Tiger Beetle (Figure 2) inhabits western North America, from the southwestern corner of B.C. south through western Washington and Oregon to northwestern California. The species ranges through the coastal lowlands but is also recorded from east of the Cascade Mountains in the Columbia River Valley in Benton County and through Klamath County in southwestern Oregon (Leffler and Pearson 1976; Pearson *et al.* 2005).

Figure 2. Global range of the Audouin's Night-stalking Tiger Beetle (based on Leffler and Pearson1976; Pearson *et al*. 2005; Bergdahl pers. comm. 2011).

The global extent of occurrence based on a minimum convex polygon is approximately 100,000 km^2, although may be larger. Information is based on maps in Pearson *et al*. (2006) and records for the species on the periphery of its range are unconfirmed.

Canadian Range

The Audouin's Night-stalking Tiger Beetle is restricted to the Georgia Basin within southwestern B.C. and occurs within a thin strip of coastal lowland habitat in the Boundary Bay area of the lower mainland and the Greater Victoria area of Vancouver Island (Figure 3). There are no records north of the Victoria area, on the Gulf Islands or east of Boundary Bay in the Lower Fraser Valley (see Search Effort map Figure 4). In a study of specimens collected in the United States, in which more than 1000 specimens were collated, the species had not been recorded more than a "few miles" from the coastline (van den Berghe 1990). This is true of B.C. collection records (Table 1, Figure 3) (British Columbia Conservation Data Centre 2013): all confirmed sites in B.C. are within 3 km of the marine shoreline.

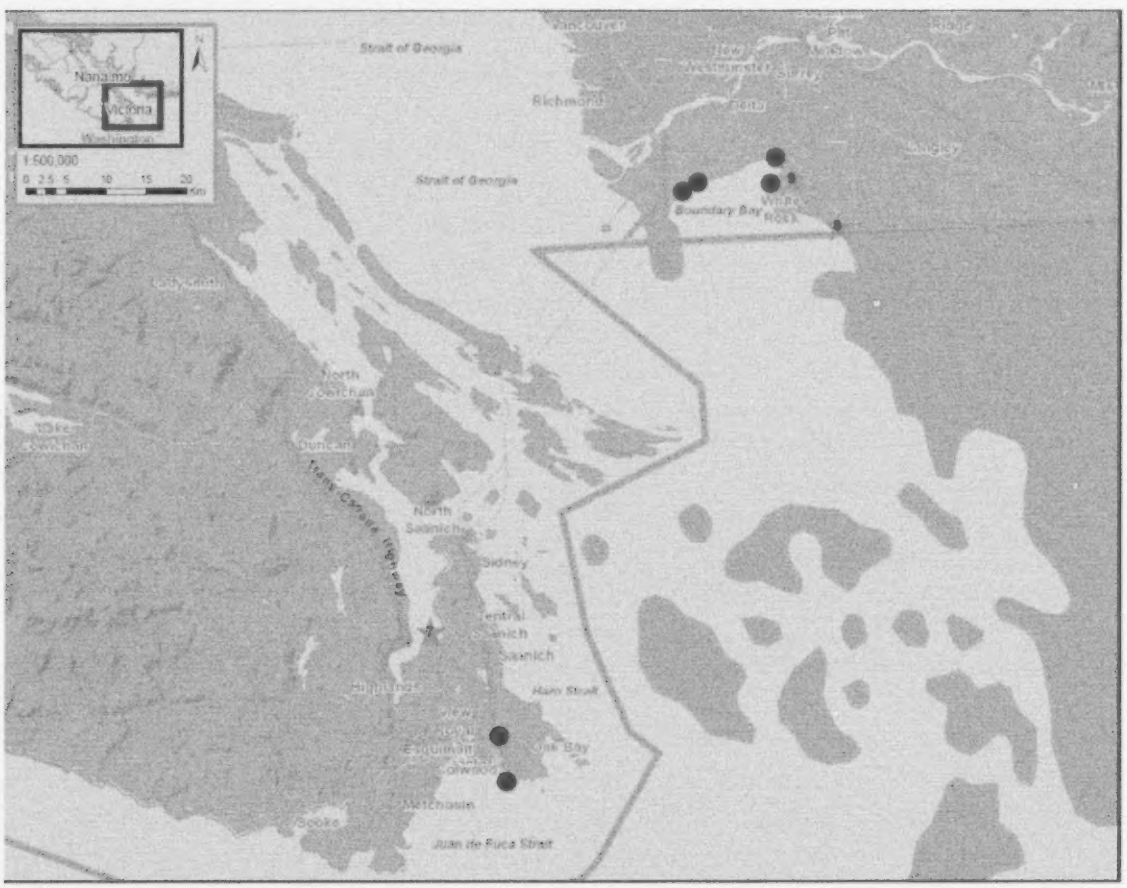

Figure 3. Canadian range and sites for the Audouin's Night-stalking Tiger Beetle (*Omus audouini*) (British Columbia Conservation Data Centre 2013). Sites 1 – 6 (red dots) are confirmed extant sites. Sites 7 – 9 (blue stars) are old records with vague site information but where suitable habitat remains. Map created by Kristina Robbins (B.C. Ministry of Forests, Lands and Resource Operations) December 6, 2012.

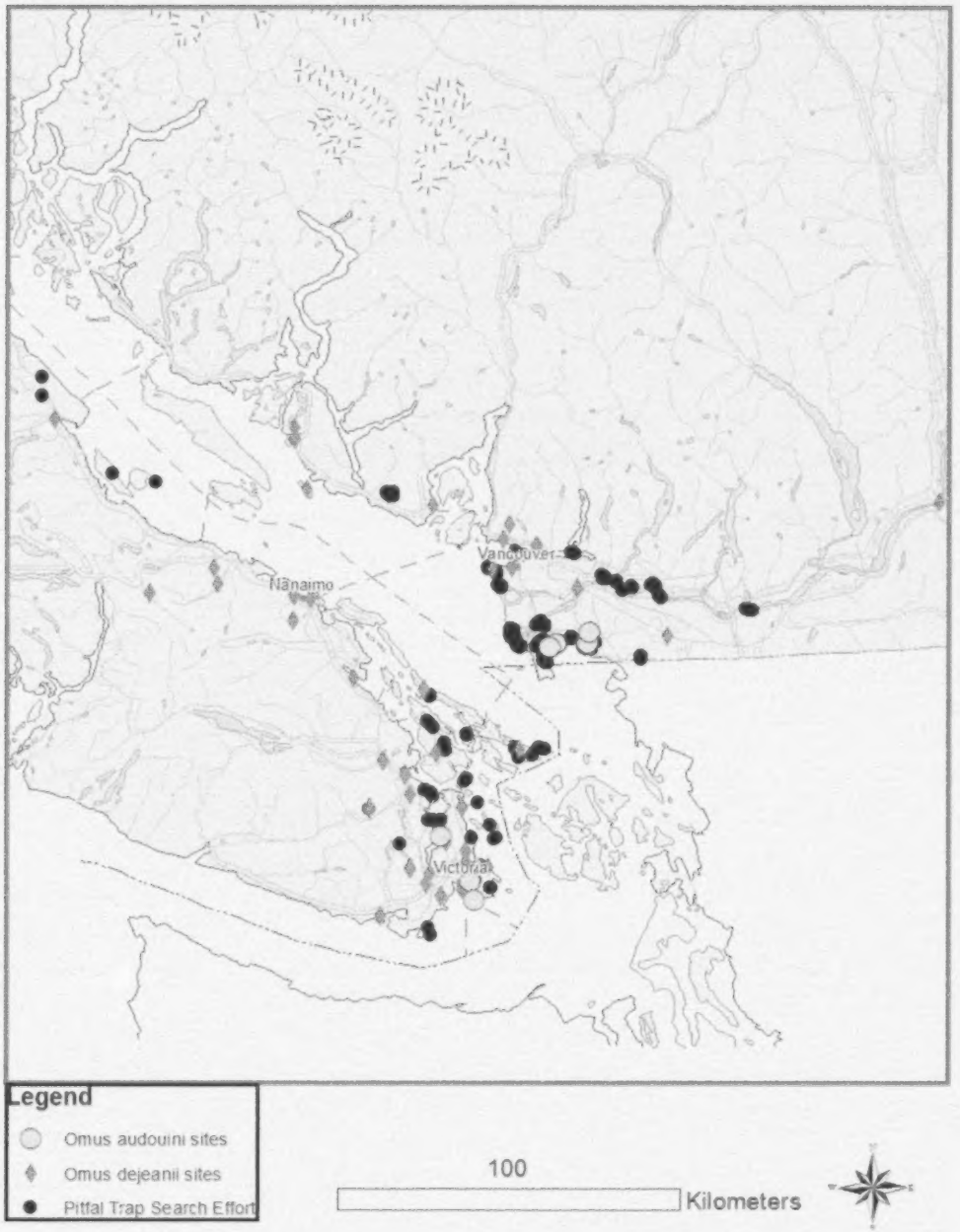

Figure 4. Search effort for the Audouin's Night-stalking Tiger Beetle. Pitfall trap sites are represented as small black dots. Pitfall trapping within southwestern B.C. from 1989 - 2012 amounts to a minimum of 722 sites and more than 73,000 trap nights (124 sites on Vancouver Island, 95 sites on southern Gulf Islands, 96 sites on the Sunshine Coast and 406 sites in the Lower Fraser Valley). Numerous traps are sometimes represented by one dot on the map. Specimen records for *Omus dejeani* (the Greater Night-stalking Tiger Beetle) are another measure of search effort for this species. Map created by Orville Dyer (B.C. Ministry of Forests, Lands and Resource Operations) September 20, 2013.

Table 1. Audouin's Night-stalking Tiger Beetle (*Omus audouini*) records and museum collections in B.C. in chronological order (British Columbia Conservation Data Centre 2013).

Year	Site Name	Municipality	Land Ownership	Collection Method	Number of Specimens	Habitat Type	Site Considered Extant or Extirpated and site number (Figure 3)	Museum Collection
1924	Victoria, Dallas Cliffs (Dallas Bluffs)	Victoria	Unknown (likely private)	Hand collection	1	Garry Oak and associated ecosystems	Extant (Site 2)	Royal B.C. Museum, Victoria, B.C.
1924	Saanich (no specific location)	Saanich	Unknown (likely private)	Hand collection	1	Likely Garry Oak and associated ecosystems	Extirpated (site 10, but not shown on Figure 3 due to vague collection site data)	Royal B.C. Museum, Victoria, B.C.
1925	Victoria, Dallas Cliffs (Dallas Bluffs)	Victoria		Hand collection	1	Garry Oak and associated ecosystems	Extant (Site 2)	Royal B.C. Museum, Victoria, B.C.
1925	Victoria, Highlands Distr. (no specific location)	Victoria	Unknown (likely private)	Hand collection	1	Likely Garry Oak and associated ecosystems	Extirpated (Site 11, but not shown on Figure 3 due to vague collection site data)	Royal B.C. Museum, Victoria, B.C.
1930	Tod Inlet	Not determinable; vague collection information	Unknown (likely private)	Hand collection	1	Could be either Garry Oak and associated ecosystems or Sparsely vegetated coastal sand ecosystems	Extant (Site 7)	California Academy of Sciences
1933	Victoria, BC	Victoria	Unknown	Hand collection	1	Unknown; likely Garry Oak and associated ecosystems	Unknown	California Academy of Sciences
1954	Victoria	Victoria	Unknown	Hand collection	1	Unknown; likely Garry Oak and associated ecosystems	Unknown	Royal B.C. Museum, Victoria, B.C.
1962	White Rock	White Rock	Unknown (likely private)	Hand collection	1	Sparsely vegetated coastal sand ecosystems	Extant (Site 8)	Canadian National Collection of Insects, Arachnids and Nematodes, Ottawa, ON
1985	Elgin (north of White Rock)	White Rock	Unknown (likely private)	Pitfall traps; May 1 – 7, 1985	1	Sparsely vegetated coastal sand ecosystems	Extant (Site 9)	Canadian National Collection of Insects, Arachnids and Nematodes, Ottawa, ON
1989	Boundary Bay (near Airport)	Delta	Private; Municipality of Delta	Pitfall traps; May 2, 1989 – June 1, 1989	12	Sparsely vegetated coastal sand ecosystems	Extant (Site 4)	Spencer Entomological Collection, Beaty Biodiversity Museum, University of British Columbia, Vancouver, B.C.
2009	Victoria, Dallas Road, Dallas Cliffs	Victoria	Private; City of Victoria, Parks Department	Pitfall traps; June 19 – July 27, 2009	1	Garry Oak and associated ecosystems	Extant (Site 2)	Royal B.C. Museum, Victoria, B.C.
2010	Blackie Spit Surrey Municipal Park	Surrey	Private; City of Surrey	Pitfall traps; May 7 – June 1, 2010	2 F	Sparsely vegetated coastal sand ecosystems	Extant (Site 3)	Royal B.C. Museum, Victoria, B.C.
2010	Blackie Spit Surrey Municipal Park	Surrey	Private; City of Surrey	Pitfall traps; May 7 – June 1, 2010	1 M	Sparsely vegetated coastal sand ecosystems	Extant (Site 3)	Royal B.C. Museum, Victoria, B.C.

Year	Site Name	Municipality	Land Ownership	Collection Method	Number of Specimens	Habitat Type	Site Considered Extant or Extirpated and site number (Figure 3)	Museum Collection
2010	Blackie Spit Surrey Municipal Park	Surrey	Private; City of Surrey	Pitfall traps; June 1 -July 7, 2010	1 F	Sparsely vegetated coastal sand ecosystems	Extant (Site 3)	Royal B.C. Museum, Victoria, B.C.
2010	Blackie Spit Surrey Municipal Park	Surrey	Private; City of Surrey	Pitfall traps; June 1 -July 7, 2010	1 M	Sparsely vegetated coastal sand ecosystems	Extant (Site 3)	Royal B.C. Museum, Victoria, B.C.
2010	Blackie Spit Surrey Municipal Park	Surrey	Private; City of Surrey	Pitfall traps; June 1 -July 7, 2010	1 F, 1 M	Sparsely vegetated coastal sand ecosystems	Extant (Site 3)	Royal B.C. Museum, Victoria, B.C.
2010	Blackie Spit Surrey Municipal Park	Surrey	Local government;; City of Surrey	Pitfall traps; July 7 – August 5, 2010	1 F, 2 M	Sparsely vegetated coastal sand ecosystems	Extant (Site 3)	Royal B.C. Museum, Victoria, B.C.
2010	Boundary Bay (72nd Street access)	Surrey	Local government;	Pitfall traps; July 5 – August 3, 2010	4 F, 5 M	Sparsely vegetated coastal sand ecosystems	Extant (Site 5)	Royal B.C. Museum, Victoria, B.C.
2010	Boundary Bay (72nd Street access)	Surrey	Local government;	Pitfall traps; August 3 – Sept 29, 2010	2 F, 1 M	Sparsely vegetated coastal sand ecosystems	Extant (Site 5)	Royal B.C. Museum, Victoria, B.C.
2010	Mud Bay Surrey Municipal Park	Surrey	Local government; City of Surrey	Pitfall traps; August 5 - September 28, 2010	1 F	Sparsely vegetated coastal sand ecosystems	Extant (Site 6)	Royal B.C. Museum, Victoria, B.C.
2010	Mud Bay Surrey Municipal Park	Surrey	Private; City of Surrey	Pitfall traps; June 2 - July 8, 2010	1 F, 1 M	Sparsely vegetated coastal sand ecosystems	Extant (Site 6)	Royal B.C. Museum, Victoria, B.C.
2010	Mud Bay Surrey Municipal Park	Surrey	Local government;; City of Surrey	Pitfall traps; August 5 - September 28, 2010	1 F	Sparsely vegetated coastal sand ecosystems	Extant (Site 6)	Royal B.C. Museum, Victoria, B.C.
2012	Lochside Regional Trail,		Local government; Capital Regional District	Observation and collection of specimen	1	Trailside weedy area; closest natural area is Swan Lake Nature Sanctuary; Garry Oak and associated ecosystem	Extant (Site 1)	Royal B.C. Museum, Victoria, B.C.
No date	B.C. (no location)	Not determinable; vague collection information	Unknown	Hand collection	1	Unknown	Unknown	Royal B.C. Museum, Victoria, B.C.
No date	B.C. (no location)	Not determinable; vague collection information	Unknown	Hand collection	1	Unknown	Unknown	Royal B.C. Museum, Victoria, B.C.
no year	Victoria, BC	Victoria	Unknown	Hand collection	1	Unknown	Unknown	California Academy of Sciences

The number of extant sites in Canada is estimated at nine (Table 1). Three of these sites (site 7 Tod Inlet, site 8 White Rock, and site 9 Elgin) have vague site collection information, yet are being considered extant because the general collection area is known and potential shoreline habitat remains.

Extent of Occurrence and Area of Occupancy

Based on all Canadian records the extent of occurrence (EO), using a minimum convex polygon, is 1600 km^2. The unsuitable salt-water Strait of Georgia, between the island and mainland, is included in the EO calculation.

The index of area of occupancy (IAO) is 36 km^2 (Figure 3) (= nine 2 km x 2 km grids that cover all sites in Figure 3). This calculation considers all possible extant sites (sites 1 – 9, Figure 3). If only the confirmed known sites are considered IAO is reduced to 24 km^2.

Search Effort

Search effort for the Audouin's Night-stalking Tiger Beetle has primarily been by pitfall trapping or hand collection within suitable habitat, with the main objective to record the species' presence, abundance and associated habitat information. Pitfall traps are considered an effective passive method of determining the presence of this species (van den Berghe 1990; Pearson *et al* 2005), and could potentially inform trend evaluations.

From 1989 – 2012 hand searching for Audouin's Night-stalking Tiger Beetles and pitfall trapping has resulted in the confirmation of two historical sites and the discovery of a few additional sites within the species' range in B.C. (Table 1). Because it has been suggested the species has not been collected more than a few kilometres from the coast in B.C. (British Columbia Conservation Data Centre 2013) and elsewhere within the species' range (van den Berghe 1990), the search effort focused on the edges of the species' range in southeastern Fraser Valley, Vancouver Island and a few southern Gulf Islands. Pitfall trapping within southwestern B.C. from 1989 to 2012, including Vancouver Island, amounts to a minimum of 722 sites (Table 2 and Figure 4) and more than 73,000 trap nights (approximately 124 sites on Vancouver Island, 95 sites on southern Gulf Islands, 96 sites on the Sunshine Coast and 406 sites in the Lower Fraser Valley).

Table 2. Audouin's Night-stalking Tiger Beetle in B.C.: sites considered extant (British Columbia Conservation Data Centre 2013).

Site	Most Recent Collection Year	Site Name	Fragmentation and Isolation	Land Ownership	Zone	Easting	Northing
1	2012	Lochside Regional Trail	Yes; adjacent habitat is Swan Lake Nature Sanctuary; may be some habitat in the trailside verges	Local government; Capital Regional District (collection site) and multiple private landowners in surrounding habitats	10	472203	5367304
2	2009	Victoria, Dallas Road, Dallas Cliffs, Vancouver Island	Yes; Dallas Road runs through Beacon Hill Victoria Municipal Park and surrounding habitats are urban	Local government (collection site); City of Victoria, Parks Department; and multiple private landowners in surrounding habitats	10	472924	5361657
3	2010	Blackie Spit Surrey Municipal Park	Likely connected as a strip of habitat along the shoreline and fields/meadows of Boundary Bay area. Connected with site 3, 4, 5, 6	Local government (collection site); City of Surrey; and multiple private landowners in surrounding habitats	10	508890	5434250
4	1989	Boundary Bay (near Airport)	Likely connected as a strip of habitat along the shoreline and fields/meadows of Boundary Bay area. Connected with site 3, 4, 5, 6	Local government (collection site); Municipality of Delta leased to private company; and multiple private landowners in surrounding habitats	10	499796	5434777
5	2010	Boundary Bay (72nd Street access	Likely connected as a strip of habitat along the shoreline and fields/meadows of Boundary Bay area. Connected with site 3, 4, 5, 6	Local government; multiple landowners in surrounding habitat	10	497877	5433704
6	2010	Mud Bay Surrey Municipal Park	Likely connected as a strip of habitat along the shoreline and fields/meadows of Boundary Bay area. Connected with site 3, 4, 5, 6	Local government (collection site); City of Surrey; and multiple private landowners in surrounding habitats	10	509591	5437460
7	1930	Tod Inlet, BC	Likely connected as a strip of habitat along the shoreline and natural areas of Tod Inlet. Although collection record is old, there is the possibility unrecorded populations may exist.	Specific collection site unknown. Private; multiple landowners in surrounding habitat	10	464141	5380581
8	1962	White Rock	Likely connected, as a strip of habitat along the shoreline towards Boundary Bay, but adjacent habitat is a busy road and urban housing areas.	Specific collection site unknown. In general, land is private, multiple landowners in surrounding habitat, shoreline habitat is a municipally owned park.	10	516984	5428638

Site	Most Recent Collection Year	Site Name	Fragmentation and Isolation	Land Ownership	Zone	Easting	Northing
9	1985	Elgin area, north of White Rock	Likely connected, as a strip of habitat along the shoreline towards Boundary Bay, but adjacent habitat is a busy road and urban housing areas.	Specific collection site unknown. In general, land is private, multiple landowners in surrounding habitat, shoreline habitat is a municipally owned park.	10	511589	5434735
10	1924 (considered extirpated)	Saanich (no specific location)	Likely Garry Oak and associated ecosystems; extensive urban and rural development has occurred within the Saanich area	Unknown (likely private)	Not available		
11	1925 (considered extirpated)	Victoria, Highlands Distr. (no specific location)	Likely Garry Oak and associated Ecosystems; extensive urban and rural development has occurred within the Victoria Highlands area	Unknown (likely private)	Not available		

Table 3. Surveys for Audouin's Night-stalking Tiger Beetle (*Omus audouini*) on Vancouver Island, Gulf Islands and Lower Fraser Valley, B.C. Search effort measured in terms of pitfall trap nights.

Year	Site Name	Report Citation	Total Number of Pitfall Trap Nights (all traps)	Lower Mainland	Sunshine Coast	Vancouver Island	Gulf Islands
1989	Brackman Island	J. Bergdahl pers. comm. 2011	60				60
1989	North Ackland Island	J. Bergdahl pers. comm. 2011	60				60
1989	South Ackland Island	J. Bergdahl pers. comm. 2011	60				60
1989	Central Ackland Island	J. Bergdahl pers. comm. 2011	60				60
1989	Big D'Arcy Island	J. Bergdahl pers. comm. 2011	60				60
1989	Tiny D'Arcy Island	J. Bergdahl pers. comm. 2011	60				60
1989	Forrest Island	J. Bergdahl pers. comm. 2011	60				60
1989	South Hawkins Island	J. Bergdahl pers. comm. 2011	60				60
1989	East Hawkins Island	J. Bergdahl pers. comm. 2011	60				60
1989	North Hawkins Island	J. Bergdahl pers. comm. 2011	60				60
1989	Big Red Island	J. Bergdahl pers. comm. 2011	60				60
1989	Bright Island	J. Bergdahl pers. comm. 2011	60				60
1989	Glenthorne Island	J. Bergdahl pers. comm. 2011	60				60

Year	Site Name	Report Citation	Total Number of Pitfall Trap Nights (all traps)	Lower Mainland	Sunshine Coast	Vancouver Island	Gulf Islands
1989	Big Sallas Island	J. Bergdahl pers. comm. 2011	60				60
1989	Little Sallas Island	J. Bergdahl pers. comm. 2011	60				60
1989	Sidney Island	J. Bergdahl pers. comm. 2011	60				60
1989	SW Dock Island	J. Bergdahl pers. comm. 2011	60				60
1989	Big Channel Island	J. Bergdahl pers. comm. 2011	60				60
1989	Little Channel Island	J. Bergdahl pers. comm. 2011	60				60
1989	Cabbage Island, Gulf Islands National Park Reserve	J. Bergdahl pers. comm. 2011	4000				4000
1989	Tumbo Island, Gulf Islands National Park Reserve	J. Bergdahl pers. comm. 2011	3000				3000
1989	Portland Island	J. Bergdahl pers. comm. 2011	1400				1400
1992	Victoria Watershed	Craig, K. MSc Thesis 1993	28			28	
1992	Koksilah	Craig, K. MSc Thesis 1993	28			28	
2003 - 2004	Island View Beach Capital Regional District Park	R. Bennett pers. comm. 2011	10950			10950	
2004	Mary Hill	McLean, Behennah and Fairbarns 2009	600			600	
2004	Rocky Point	McLean, Behennah and Fairbarns 2009	600			600	
2004	Saturna Island, Mt. Warburton Pike; Gulf Islands National Park Reserve	Heron pers. data 2007	1624				1624
2004	Saturna Island, Lyall Creek; Gulf Islands National Park Reserve	Heron pers. data 2007	1015				1015
2004	Saturna Island, Narvez Bay; Gulf Islands National Park Reserve	Heron pers. data 2007	1015				1015
2004	Tumbo Island; Gulf Islands National Park Reserve	Heron pers. data 2007	1500				1500
2004	Cabbage Island, West side Gulf Islands National Park Reserve	Heron pers. data 2007	236				236
2007	Stanley Park, Aquarium Site, Vancouver Parks	McLean and Li 2009	114	114			
2007	Stanley Park, Hollow tree/Rawlings trail, Vancouver Parks	McLean and Li 2009	114	114			
2007	Roberts Creek, Phase 1 Dispersal Retention	Henderson Thesis 2008	2016		2016		

Year	Site Name	Report Citation	Total Number of Pitfall Trap Nights (all traps)	Lower Mainland	Sunshine Coast	Vancouver Island	Gulf Islands
2008	Stanley Park, South Creek, Vancouver Parks	McLean and Li 2009	184	184			
2008	Stanley Park, Merilees Trail, Vancouver Parks	McLean and Li 2009	184	184			
2009	Surrey Bend Metro Vancouver Park	Heron pers. data 2009	660	660			
2009	Reifel Bird Sanctuary	Heron pers. data 2009	675	675			
2009	Alaksen Wildlife Reserve; Canadian Wildlife Service federal property	Heron pers. data 2009	672	672			
2009	Belcarra Park Metro Vancouver Park	Heron pers. data 2009	524	524			
2009	Boundary Bay Metro Vancouver Park	Heron pers. data 2009	1350	1350			
2009	Iona Beach Metro Vancouver Park	Heron pers. data 2009	1570	1570			
2009	Colony Farm Metro Vancouver Park	Heron pers. data 2009	528	528			
2009	Saxe Pointe	Teucher pers. data 2010	512			512	
2009	Beacon Hill Victoria Municipal Park	Teucher pers. data 2010	368			368	
2009	Christmas Hill Bird Sanctuary	Teucher pers. data 2010	536			536	
2009	Dallas Cliffs; Beacon Hill Municipal Park	Teucher pers. data 2010	322			322	
2009	Island View Beach Capital Regional District Park	Teucher pers. data 2010	528			528	
2009	Island View Beach Capital Regional District Park	Teucher pers. data 2010	600			600	
2010	Oak bay; Cattle Point Park	Teucher pers. comm.. 2010	97			97	
2010	Oak bay; Uplands Park	Teucher pers. comm. 2010	114			114	
2010	Saanich; Mount Douglas Park	Teucher pers. comm. 2010	89			89	
2010	Saanich; Playfair Park	Teucher pers. comm.. 2010	61			61	
2010	Victoria; Holland Point Park	Teucher pers. comm. 2010	96			96	
2010	Victoria; Beacon Hill Park	Teucher pers. comm. 2010	407			407	
2010	Blackie Spit Surrey Municipal Park	Parkinson and Heron 2010	1057	1057			
2010	Blackie Spit Surrey Municipal Park	Parkinson and Heron 2010	180	180			

Year	Site Name	Report Citation	Total Number of Pitfall Trap Nights (all traps)	Lower Mainland	Sunshine Coast	Vancouver Island	Gulf Islands
2010	Boundary Bay (12 Ave); Metro Vancouver Parks	Parkinson and Heron 2010	1246	1246			
2010	Boundary Bay (72 Ave); Metro Vancouver Parks	Parkinson and Heron 2010	860	860			
2010	Bow Chong Farm Ltd.	Parkinson and Heron 2010	423	423			
2010	Brent Kelly Farms Inc.	Parkinson and Heron 2010	784	784			
2010	Canoe Pass Farms Ltd.	Parkinson and Heron 2010	696	696			
2010	Crescent Park, Surrey Parks	Parkinson and Heron 2010	360	360			
2010	Dhaliwal Farms Ltd.	Parkinson and Heron 2010	570	570			
2010	Elgin Heritage Park, Surrey Municipal Park	Parkinson and Heron 2010	755	755			
2010	Fraserland Farms - 64 Street	Parkinson and Heron 2010	770	770			
2010	Fraserland Farms - Deltaport	Parkinson and Heron 2010	660	660			
2010	Fraserland Farms - Gaudy Rd	Parkinson and Heron 2010	570	570			
2010	Fraserland Farms Highway 17 (private) (DFWT)	Parkinson and Heron 2010	627	627			
2010	Grove Crest Farms Ltd.	Parkinson and Heron 2010	600	600			
2010	Hunterston Farm	Parkinson and Heron 2010	66	66			
2010	Mud Bay Surrey Municipal Park	Parkinson and Heron 2010	476	476			
2010	Reynelda Farms	Parkinson and Heron 2010	1008	1008			
2010	Zellweger Farms "B"	Parkinson and Heron 2010	744	744			
2010	Zellweger Farms "C"	Parkinson and Heron 2010	924	924			
2012	Lochside trail, just south of Vernon Ave	Andy Teucher pers. comm. 2012	Hand Collected			Hand Collected	
2012	Brae Island Regional Park	Heron pers. data 2012	801	801			
2012	Campbell Valley Metro Vancouver Regional Park	Heron pers. data 2012	1164	1164			
2012	Colony Farm Metro Vancouver Regional Park	Heron pers. data 2012	1035	1035			
2012	Deas Island Metro Vancouver Regional Park	Heron pers. data 2012	1305	1305			

Year	Site Name	Report Citation	Total Number of Pitfall Trap Nights (all traps)	Lower Mainland	Sunshine Coast	Vancouver Island	Gulf Islands
2012	Derby Reach Metro Vancouver Regional Park	Heron pers. data 2012	979	979			
2012	Iona Beach Metro Vancouver Regional Park	Heron pers. data 2012	1116	1116			
2012	Matsqui Trail Metro Vancouver Regional Park	Heron pers. data 2012	1410	1410			
2012	Pacific Spirit Metro Vancouver Regional Park	Heron pers. data 2012	1581	1581			
2012	Pitt River Greenway Metro Vancouver Regional Park	Heron pers. data 2012	1034	1034			
2012	Roberts Bank Metro Vancouver Regional Park	Heron pers. data 2012	960	960			
2012	Swan Lake Nature Preserve	Heron pers. data 2012	896			896	
2012	Mount Douglas Saanich Park	Heron pers. data 2012	1386			1386	
2012	Beacon Hill City of Victoria Parks	Heron pers. data 2012	433			433	
2012	James Island Water Taxi Dock	Heron pers. data 2012	560				560
2012	James Island Powder Dock	Heron pers. data 2012	560				560
2012	James Island North Spit	Heron pers. data 2012	1120				1120
2012	Alaksen Wildlife Reserve; Canadian Wildlife Service federal property	Tanaka pers. data 2012	1326	1326			
2012	Helliwell Provincial Park, Hornby Island	Heron pers. data 2012	1056				1056
2012	Fillongley Provincial Park, Denman Island	Heron pers. data 2012	1320				1320
2012	Denman Clearcuts	Heron pers. data 2012	did not find traps				did not find
2012	Denman Clearcuts	Heron pers. data 2012	did not find traps				did not find
2012	Neck Point Park, Nanaimo, BC	Heron pers. data 2012	42			42	
		Grand Total		73025 pitfall trap nights			

Historic sites were confirmed for site 2 (Dallas Road), and the Boundary Bay area (sites 3, 4, 5, 6). One new site was recorded in 2012 (site 1 Lochside Trail). Three new sites were recorded within the contiguous strip of habitat along Boundary Bay (sites 3, 5, 6). None of these new records extended the known range of the species. Based on this information, we estimate there may be 1 – 3 unrecorded new sites. It is important to note, however, that the remaining potential sites are considered of lower habitat quality.

Various conservancies working within the range of this species have not recorded it, although these organizations are aware of the species and the similar Greater Night-stalking Tiger Beetle: Salt Spring Island Conservancy (Annschild pers. comm. 2012), Mayne Island Conservancy (Dunn pers. comm. 2012); Galiano Island Conservancy (Crowe pers. comm. 2012); South Coast Conservation Program (Zevit pers. comm. 2012). E-Fauna (Klinkenberg pers. comm. 2012) and some private consultants (Bianchini pers. comm. 2012; McDonnell pers. comm. 2011) search for the species when in suitable habitat or send photos to confirm identification (Heron pers. comm. 2012).

HABITAT

Habitat Requirements

In general, abiotic factors that limit moisture, such as temperature, water availability, and day length, contribute to the overall activity patterns of tiger beetles and their presence within a habitat patch (Pearson and Vogler 2001; Pearson *et al.* 2005). Microhabitat features, including soil type content and friability, soil organic matter, understory vegetation, and bryophyte layers define beetle and larval activity, reproductive success and larval sites, foraging, and persistence within a habitat patch.

The Audouin's Night-stalking Tiger Beetle inhabits low elevation coastal terrain. All sites in B.C. are less than 20 m above sea level [asl] and within 3 km of the marine shoreline (British Columbia Conservation Data Centre 2013). Adults are epigean (ground crawling), heliophilic (heat loving), and wander in forest meadow margins (Larochelle and Lariviere 2001) and other open, sunny sites (Pearson *et al.* 2005). Overall, habitat includes open grassy areas, coastal bluffs, meadows, open forests, older agricultural fields (no crops present for a number of years), and similar habitats.

The Audouin's Night-stalking Tiger Beetle is recorded from two ecosystem types in B.C.: 1) sparsely vegetated sand ecosystems (six extant sites) and 2) Garry Oak and associated ecosystems (three extant sites; likely the two historic sites; and areas elsewhere within the species' global range).

Sparsely vegetated ecosystems have significant areas of exposed bare ground, short turf grasses and dry exposed areas and include coastal sand and gravel spits and coastal sand dunes (Ward *et al.* 1998).

Blackie Spit (site 3; Figure 5), Boundary Bay Regional Park (site 5; Figure 6) and Mud Bay Municipal Park (site 6; Figure 7) are classified as sparsely vegetated sand ecosystem habitats. The habitats at Boundary Bay airport (site 4) likely also have similar ecosystem components, although the site is privately owned and vegetation surveys have not been completed. These four sites, and similar adjacent unsurveyed habitat, are part of an "extensive series of relict sand spits developed from eroding bluffs along the east and southeast shores of Point Roberts, U.S." (Page *et al.* 2011). There are three plant communities in the sand ecosystems at Boundary Bay sites (3, 5, 6 and likely 4):

1) The American Searocket (*Cakile edentula*) community forms a narrow band along the shore and is widespread and common in the Georgia Basin. Dominant vegetation includes Dune Wildrye (*Leymus mollis* ssp. *mollis*) and Red Fescue (*Festuca rubra*). This plant community is unranked (British Columbia Conservation Data Centre 2013).

2) The Large-headed Sedge (*Carex macrocephala*) community is found on rapidly drained sites having low soil moisture and poor nutrient availability, with introduced grasses being common. This community occupies a large proportion of the sand flats and is typically on the upper to mid-elevation, sandy areas. Dominant species include Large-headed Sedge, Red Fescue, and Puget Sound Gumweed. This plant community is Red-listed (British Columbia Conservation Data Centre 2013).

3) The Pacific Wormwood — Red Fescue — Racomitrium Moss (*Artemisia campestris — Festuca rubra s.l. — Racomitrium canescens*) community is highly variable in plant species composition, although most of the plants are similar to the Large-headed Sedge community. Dominant species include Large-headed Sedge, Red Fescue and Puget Sound Gumweed. This plant community is Red-listed (British Columbia Conservation Data Centre 2013).

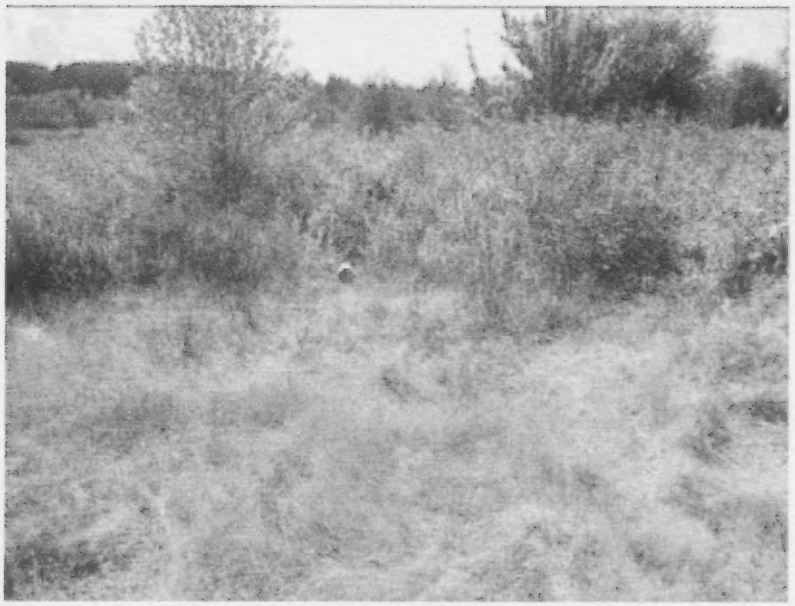

Figure 5. Site 3, Blackie Spit Municipal Park, Surrey, B.C. Photograph by Jennifer Heron, August 27, 2010.

Figure 6. Site 5, Boundary Bay Regional Park (72nd Street Access), Delta, B.C. Photograph by Laura Parkinson, July 5, 2010.

Figure 7. Site 6, Mud Bay Municipal Park, Surrey, B.C. Photograph by Jennifer Heron. March 23, 2011.

The Audouin's Night-stalking Tiger Beetle has also been recorded from Garry Oak ecosystems (Site 2 Dallas Road), which occur on the eastern side of Vancouver Island, from the greater Victoria area north to the Comox area; throughout the southern Gulf Islands as far north as Savary Island in the Strait of Georgia (Garry Oak Ecosystems Recovery Team 2012). Garry Oak ecosystems have been described in detail by Roemer (1972) and Erickson (1993, 1995). In general, these ecosystems are described as open meadow habitats composed of sparsely treed Garry Oak (*Quercus garryana* Douglas ex Hook.), Arbutus (*Arbutus menziesii* Pursh), Douglas-fir (*Pseudotsuga menziesii* (Mirbel) Franco), and other trees (Fuchs 2000). Understory vegetation includes native and introduced grasses and a high diversity of forbs and various shrubs. See Fuchs (2000) for further descriptions of the plants in this ecosystem.

The three sites where the beetle is considered extirpated (see Table 1), labelled 'Victoria' (collected in 1933; and another with an unknown collection date), 'Victoria, Highlands' (collected in 1925) and "Saanich" (collected in 1924), were likely also Garry Oak habitats.

The Audouin's Night-stalking Tiger Beetle has also been recorded in abundance from Garry Oak habitats in Washington State at Mima Mounds Prairie (WA) (1487 specimens) and Glacial Heritage (WA) (6 specimens) (Maynard 2007). Mima Mounds Prairie is a large open, state-owned property that was partially cleared of Douglas-fir as part of restoration activities. Glacial Heritage is also prairie habitat (Maynard 2007).

Although the Audouin's Night-stalking Tiger Beetle is recorded from sparsely vegetated sand ecosystems and Garry Oak ecosystems, there is still a minor (< 10%) component of overstory tree composition at known sites (3, 5, 6). Overstory tree composition at B.C. sites is sparse (< 10% cover and typically clumped distribution) and includes Western Hemlock (*Tsuga heterophylla* (Raf.) Sarg), Douglas-fir, pine species (*Pinus* spp.), Bigleaf Maple (*Acer macrophyllum*), Black Cottonwood (*Populus trichocarpa*), Red Alder (*Alnus rubra*), Garry Oak and Western Red Cedar (*Thuja plicata*). Tree cover age ranges from saplings to trees greater than 80 years.

Soil composition is important for larval burrow sites. The fossorial larvae (Larochelle and Lariviere 1990) have not been observed in B.C. Information from other *Omus* species notes most burrows are located within clay banks with up to 50% slope and often above ocean high-tide areas and coastal bluffs above the marine shoreline, adjacent to hiking trails and within road cuts, stream banks and other similar habitats (van den Burghe 1990; Larochelle and Lariviere 1990). *Omus* burrows are rarely on flat ground (van den Burghe 1990). The Dallas Road site (site 2) is at the base of a steep clay embankment (up to 50% slope), and larval tunnels are likely within slopes above the high tide zone. Conversely, Blackie Spit Municipal Park (site 3) has the highest recorded number of adult beetles (25 adults in 2010), yet has little overall slope (< 5%).

Larval tunnels observed in Washington State (see van den Burghe 1990) were located in a clay bank above the high tide mark within high grass and Red Alder saplings. The best substrate for larval development appears to be fine clayey soil (van den Burghe 1990) that allows for a deep (15 – 30 cm) larval tunnel to be developed (Maser 1977a) and maintained for up to three years (Pearson *et al.* 2005; Larochelle and Lariviere 2001). Other substrate includes fine sand and, rarely, very coarse-grained granitic sand (van den Burghe 1990). Larvae are confined to their burrows, and lie in wait with their head protruding slightly from the open hole. To aid the larva's success when capturing large prey, there are hooks on the 5th abdominal sternum that act to anchor the larvae to the burrow. Prey is dragged to the bottom of their burrow once captured and subdued (Bland 1978).

Larval burrows tend to be on south-facing slopes. In B.C., the dry open sites where the Audouin's Night-stalking Tiger Beetle is recorded can reach temperatures up to 35°C in July and August. The species occupies sites with shallow litter depth (very little leaf needle). Soil pH requirements are unknown.

Audouin's Night-stalking Tiger Beetle adults are considered opportunistic in their selection of cover: they most frequently take cover under wood and logs (212 of 220 beetles caught were under wood; Maser 1971, 1977ab), stones, dead leaves and open forest floor litter (van den Berghe 1990; Freitag 1999; Larochelle and Lariviere 2001; Pearson *et al.* 2005).

The Audouin's Night-stalking Tiger Beetle is considered eurytopic, and appears to be tolerant of some forms of habitat disturbance, although the species does not appear to depend on dynamic environmental factors such as fire or flooding. All known sites are in areas potentially flooded by seawater or periodic freshwater floods due to rain runoff; and all sites are high recreation habitats with a component of both non-native and native invasive species. Anthropogenic cover objects include black plastic, tar paper and old automobile tires (Maser 1977a).

Audouin's Night-stalking Tiger Beetle adults likely maintain a home range within which to forage, find mates and reproduce. Home range size is unknown and has not been studied for any *Omus* species. The species is flightless and thus dispersal is limited to running or walking. The species is considered a 'moderately fast runner' (Larochelle and Lariviere 2001).

A map of potential habitat for Audouin's Night-stalking Tiger Beetle is given in Figure 8.

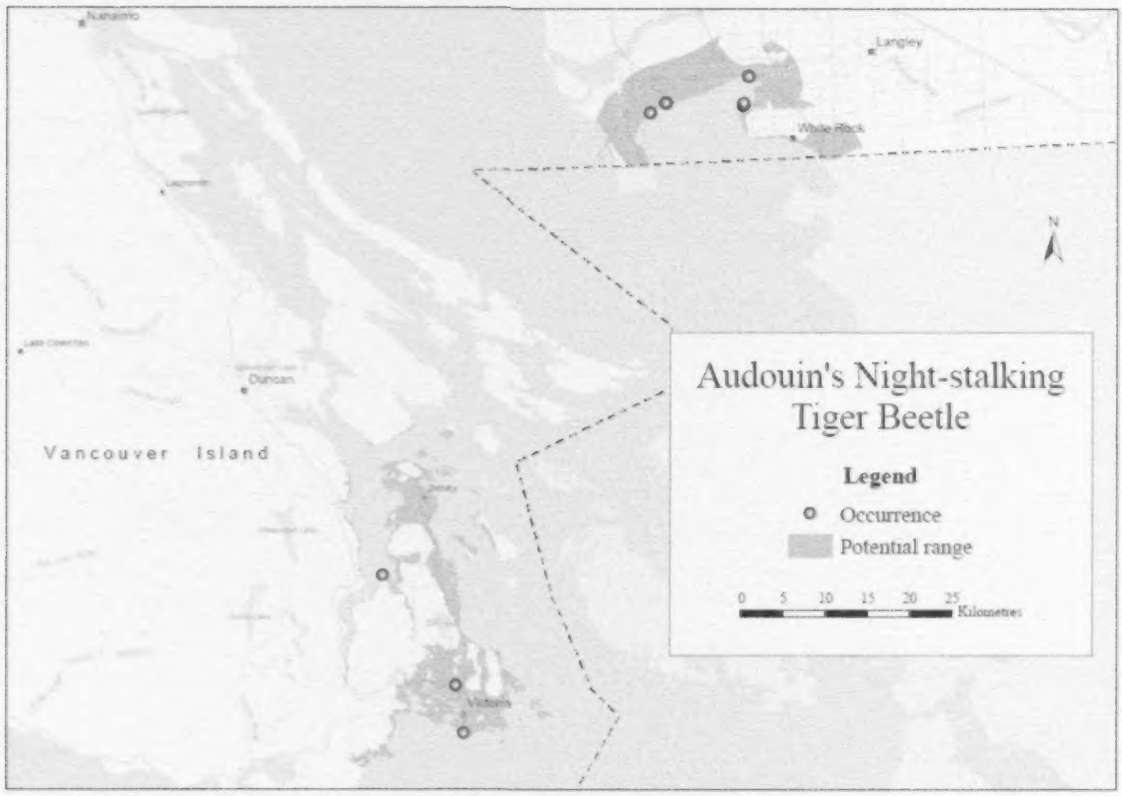

Figure 8. Potential habitat of the Audouin's Night-stalking Tiger Beetle (< 50m elevation) within the known range of the species in B.C. Map completed by Byron Woods (B.C. Ministry of Environment, June 2013).

Habitat Trends

Six out of ten British Columbians live within the Lower Mainland and southwest corner of the province, which is also considered the fastest growing region of the province (WorkBC 2012). The greater Victoria area is also growing, and has approximately 8 percent of the provincial population (WorkBC 2012). Most low elevation, sparsely vegetated, open meadow and fallow field habitats throughout the known range of the Audouin's Night-stalking Tiger Beetle and within 3 km of the marine shoreline have been extensively modified over the past 100 years. Cumulative impacts from intensive recreational activity, construction of urban and commercial buildings, roads and transportation corridors, the spread of invasive plants, and natural forest succession have contributed to the overall decline in the quantity and quality of the ecosystems from which this beetle has been recorded.

The most recent information on habitat trends for sparsely vegetated and Garry Oak ecosystem types from which the Audouin's Night-stalking Tiger Beetle has been recorded is from the Sensitive Ecosystem Inventory project on southeastern Vancouver Island carried out between 1993 and 1997 (Ward *et al.* 1998) and again in 2002 (Canadian Wildlife Service and B.C. Ministry of Environment 2002; Kirkby and Cake 2004). Sparsely vegetated ecosystems cover less than 0.1% (335 ha) of the east coast of Vancouver Island and adjacent Gulf Islands and are the rarest of the sensitive ecosystem types. Most of these areas are small, each less than five hectares. There are 26 coastal spits (111.3 ha), 8 dunes (39.5 ha) and 52 inland cliffs and bluffs (184.2 ha) (Ward *et al.* 1998). Unmodified examples are extremely rare because most are close to human population centres (e.g., site 2, Cordova Spit) and thus highly disturbed by introduced species such as Scotch Broom (*Cytisus scoparius*) and introduced grasses, recreational trails, fragmentation and other impacts (Ward *et al.* 1998) (see **Threats and Limiting Factors**).

Overall, open sparsely vegetated plant communities are susceptible to the colonization of invasive plants (see **Threat 8.1 Invasive non native/alien species**).

Much historical Garry Oak ecosystem habitat has been lost to development or is degraded due to invasive species and human activities (Garry Oak Ecosystems Recovery Team 2012) (see also **Threats and Limiting Factors**). Approximately ten percent (approximately 1589 ha of the pre-European contact 15 249 ha) of the Garry Oak ecosystem type remains on southeastern Vancouver Island (Lea 2006).

Historically, low intensity, frequent fires played an important role in the maintenance of Garry Oak ecosystems (Daubenmire 1968; Agee 1993; McPherson 1997; Fuchs 2000). Fire exclusion has resulted in gradual changes to the plant community composition (McCoy 2006) yet it is unknown how these changes affect the Audouin's Night-stalking Tiger Beetle.

The introduction and gradual spread of non-native plants has led to further decline in the quality and composition of both Garry Oak plant communities (see **Threats and Limiting Factors**). Habitat remnants that contain near-natural Garry Oak ecosystem understory vegetation comprise less than five percent of the original ecosystem (Lea 2006, Garry Oak Ecosystems Recovery Team 2012).

Climate change may allow the expansion of the area within which Garry Oak ecosystems are found on southern Vancouver Island (Hebda 2004). It is likely that the Garry Oak will be able to expand its geographic range, but it is less likely that the associated understory plant communities will be able to concurrently expand their ranges (Lea 2006) (see **Threats and Limiting Factors**).

Much of the coastline habitat along the Georgia Strait is subject to sea level rise within the next 100 years (Thomson *et al.* 2008; Kangasniemi 2009; Forseth 2012). In the past decade, a combination of high tides, marine storm surges and flooded rivers in the Boundary Bay area have impacted at least three sites (3, 5, 6) and have likely impacted three additional sites (4, 8, 9).

BIOLOGY

Life Cycle and Reproduction

The life cycle of the Audouin's Night-stalking Tiger Beetle (and other *Omus*) has not been well studied.

Audouin's Night-stalking Tiger Beetles mate sometime in the early spring. Mating and copulation has not been observed in B.C.; however, mating pairs have been observed in Oregon from April 10 to June 28 (7 different pairs over 7 dates) (Maser 1977a). Mating pairs were all under cover, usually wood (Maser 1977a). Tiger beetle adults (in general) lay 10 – 20 eggs per day (in captivity; numbers of eggs per day is not known in wild populations) within suitable substrate (see **Habitat**) throughout early spring. Depending on the species and local temperature conditions, eggs hatch 9 to 38 days later (Pearson and Vogler 2001).

Tiger beetles spend from 1 to 3 years in the larval stage, during which time they excavate long, deep and narrow cylindrical tunnels and develop through three instars. The larval tunnels of Audouin's Night-stalking Tiger Beetles are 20 – 35 cm in depth (Maser 1977a) and dug into half-inclined slopes of hard-packed soils (Larochelle and Lariviere 2001). Larvae close their tunnels during winter months (Maser 1977a). Larvae can flip soil pellets from the mouth of their burrow and evidence of larval presence can be observed by soil pellet accumulation up to 12.5 cm from the oval larval tunnel entrance (Maser 1977a).

Pupation takes place after the third larval instar within a chamber at the bottom of the larval burrow. Pupation lasts 18 to 30 days but sometimes longer if undergone over winter months. Following pupation, adults emerge from pupal chambers sometime in the early spring and live for 8 to 10 weeks. In B.C. adults have been caught in traps as early as May 2 and as late as September 29 (see Table 1). The sex ratio of beetles collected over a three-year period in Oregon was 61 males and 50 females (Maser 1977a).

The Audouin's Night-stalking Tiger Beetle was originally thought to be entirely nocturnal (Leng 1902; Comstock 1920); however, more recent information suggests the beetle is active at all hours (Maser and Beer 1971; Leffler 1979; Larochelle and Lariviere 2001; Teucher pers. comm. 2013). Both adults and larvae are voracious opportunistic predators, feeding on a variety of small arthropods, including ants and centipedes (Larochelle and Lariviere 2001). Adults actively hunt and crawl at moderate speeds above the ground, taking cover under substrates such as litter or coarse woody debris (see Habitat). Larvae are sit-and-wait predators, predominantly confined to their burrows.

Physiology and Adaptability

Tiger beetle activity (in general) is governed by surface and ambient temperature (Pearson and Vogler 2001). Adults are less active at lower temperatures (Maser and Beer 1971; Larochelle and Lariviere 2001). The larvae overwinter in sealed burrows (Maser 1977a; Larochelle and Lariviere 2001). Like most tiger beetles, larvae appear sensitive to ground freezing and likely cope with declining temperatures by burrowing deeper where possible.

Adult females lay eggs within "moist to dry soil consisting of clay or loamy sand and covered with needles or vegetated with grass" (Larochelle and Lariviere 2001). The mainland sites (3, 4, 5, 6) are within areas of potential flooding, and adjacent similar shoreline habitat is subject to seasonal storm surges. It is unclear if the Audouin's Night-stalking Tiger Beetle could adapt to changing climatic or habitat conditions.

Tiger beetles rely on open habitats and line-of-sight for foraging; thus it is possible that habitat selection is based on behavioural qualities. Audouin's Night-stalking Tiger Beetles have been documented using discarded, non-natural cover objects such as plastic, tarpaper and automobile tires (Maser 1977a; Larochelle and Lariviere 2001). Further, the beetles are present within sites that are highly disturbed by recreational activity (all sites); thus they appear able to tolerate some form of anthropogenic disturbance.

Dispersal and Migration

Audouin's Night-stalking Tiger Beetle adults are flightless and the species does not jump. Adults are stocky and robust crawlers that can may disperse hundreds of metres given their size and dispersal limitations. The extent of long distance dispersal and migration in this species has not been documented. Under current conditions of isolated habitats, it is unlikely the species would be able to disperse far except perhaps via passive rafting.

Interspecific Interactions

The Greater Night-stalking Tiger Beetle is frequently recorded in the same habitats (Larochelle and Lariviere 2001), and is more common throughout southwestern B.C. (Pearson *et al.* 2004). A recent study based on sexual size dimorphism and morphological characters suggested that the Audouin's Night-stalking Tiger Beetle and the Greater Night-stalking Tiger Beetle might form an intraguild relationship (see Richardson 2011). Both these species are found in similar habitats, and where Audouin's Night-stalking Tiger Beetles are found, Greater Night-stalking Tiger Beetle are typically also recorded. However the opposite does not appear to be true. In B.C., the Greater Night-stalking Tiger Beetle has a somewhat wider distribution, including records on the west coast of Vancouver Island (Tofino), a few Gulf Islands (Galiano, Denman), the lower mainland (North Vancouver, Langley), Sunshine Coast and Osoyoos (southern interior) (Figure 8).

Larvae may be parasitized by fungi (Maser and Beer 1971; Larochelle and Lariviere 2001). Wingless parasitic wasps (Family Tiphiidae, *Methocha* spp.) are known to lay their eggs on larvae of *Cicindela* (Burdick and Wasbauer 1959).

Tiger beetle species co-occurring within similar habitats may compete for food, although temporal habitat partitioning is also a relatively common occurrence (Pearson and Vogler 2001). In captivity, Audouin's Night-stalking Tiger Beetles readily attacked and consumed native centipedes (e.g., *Scolopendra serspinosa* G. Newport) over other assorted invertebrates (Maser 1977a).

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

Pitfall trapping and hand-searching surveys record the species' presence within a habitat (see **Search Effort**), but do not yield population estimates.

Abundance

There are insufficient data to provide an accurate estimate of Audouin's Night-stalking Tiger Beetle abundance in Canada. Most observations are of one or two individuals at a given site (Table 1). In the past ten years the species has been collected at six sites (Figure 3 sites 1 – 6), four of which are considered the same location (site 3, 4, 5, 6). Sites mapped by the British Columbia Conservation Data Centre (2013) and data gathered during the preparation of this status report provide presence/absence information only. Audouin's Night-stalking Tiger Beetles have been caught as a single specimen in 2009 (site 2: Victoria Dallas Road), 12 individuals in 2010 (site 3: Blackie Spit Surrey Municipal Park) and 12 individuals in the spring of 1989 (site 4: Boundary Bay near airport) (British Columbia Conservation Data Centre 2013).

Fluctuations and Trends

There is no information on population fluctuations or trends for the Audouin's Night-stalking Tiger Beetle or other beetles in the genus *Omus*.

Rescue Effect

Audouin's Night-stalking Tiger Beetle adults are flightless, and although considered moderate runners (Larochelle and Lariviere 2001), it is unlikely that they could significantly disperse through terrestrial habitats without some form of carrier-related dispersal mechanism. There is suitable habitat south along the Canadian shoreline from Blackie Spit (site 6) that connects to habitat in Washington State. However, unless unrecorded populations remain between these two geographic areas, it is unlikely rescue will occur. The closest known confirmed site on the mainland is Bellingham (Whatcom County), Washington State (Leffler and Pearson 1976), 37 km straight distance to the south from potential habitat at White Rock beach (an historical, vague site record) and 43 km from Blackie Spit (site 3). The closest U.S. habitat to the Dallas Road site (site 2) is within the San Juan Islands (no confirmed record), approximately 20 km (straight distance) across the saltwater Strait of Georgia. Audouin's Night-stalking Tiger Beetle populations could remain within unchecked habitat or extirpated sites in B.C. (Table 1), which could provide rescue habitat.

THREATS AND LIMITING FACTORS

The International Union of Conservation-Conservation Measures Partnership (2006) (IUCN-CMP) threats calculator was used to classify and list threats to the Audouin's Night-stalking Tiger Beetle (Salafsky *et al.* 2008; Master *et al.* 2009). The overall Threat Impact for the Audouin's Night-stalking Tiger Beetle is High (Table 4). Specific threats that are considered Medium, Low, or potentially significant (but Unknown at present) include residential and commercial development, pollution (pesticides), agriculture, human intrusions and disturbance, natural system modification, invasive and other problematic species, and climate change and severe weather. These threats are discussed below in descending order of Threat Impact. Applicable threats are further discussed below under the IUCN-CMP level 1 headings and summarized in Table 5.

Table 4. Threat classification table for Audouin's Night-stalking Tiger Beetle. The impacts of the individual threats roll up to an overall threat calculation of High. This threat classification is based on the IUCN-CMP (World Conservation Union–Conservation Measures Partnership) unified threats classification system and is consistent with methods used by COSEWIC, British Columbia Conservation Data Centre and B.C. Conservation Framework (B.C. Ministry of Environment 2011a). For a detailed description of the threat classification system, see the Conservation Measures Partnership website (CMP 2006). For information on how the values are assigned, see Master *et al.* (2009) and table footnotes for details. Threats for Audouin's Night-stalking Tiger Beetle were assessed across the species geographic range in Canada (Table 1).

	Threat	Impact (calculated)	Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1	Residential & commercial development	Medium	Restricted (11-30%)	Extreme (71-100%)	High (Continuing)	Applicable to much of the surrounding habitat
1.1	Housing & urban areas	Medium	Restricted (11-30%)	Extreme (71-100%)	High (Continuing)	Site 2 Dallas Road Bluffs
1.2	Commercial & industrial areas	Not a Threat (in the assessed timeframe)	Small (1-10%)	Extreme (71-100%)	Low (Possibly in the long term, >10 yrs)	Site 4 & 5 adjacent habitats potentially converted to greenhouse construction on agricultural land reserve
1.3	Tourism & recreation areas	Low	Small (1-10%)	Slight (1-10%)	Moderate (Possibly in the short term, < 10 yrs)	Golf courses - severity is less; Trails = good for beetles to forage on
2	Agriculture & aquaculture	Low	Small (1-10%)	Slight (1-10%)	Moderate (Possibly in the short term, < 10 yrs)	
2.1	Annual & perennial non-timber crops	Low	Small (1-10%)	Slight (1-10%)	Moderate (Possibly in the short term, < 10 yrs)	Applicable to habitat surrounding collection sites in the Site 4 and 5 Boundary Bay area.
2.2	Wood & pulp plantations					N/A
2.3	Livestock farming & ranching	Negligible	Negligible (<1%)	Negligible (<1%)	Moderate (Possibly in the short term, < 10 yrs)	Applicable to habitat surrounding collection sites in the Boundary Bay area.
2.4	Marine & freshwater aquaculture					N/A
3	Energy production & mining					
3.1	Oil & gas drilling					N/A
3.2	Mining & quarrying					N/A
3.3	Renewable energy					N/A
4	Transportation & service corridors	Not a Threat (in the assessed timeframe)	Unknown	Slight (1-10%)	Insignificant/ Negligible (Past or no direct effect)	
4.1	Roads & railroads	Not a Threat (in the assessed timeframe)	Unknown	Slight (1-10%)	Insignificant/Negligible (Past or no direct effect)	Considered; may occur in surrounding habitat.
4.2	Utility & service lines					N/A
4.3	Shipping lanes					N/A

	Threat	Impact (calculated)	Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
4.4	Flight paths					N/A
5	Biological resource use	Negligible	Pervasive	Negligible	Ongoing	
5.1	Hunting & collecting terrestrial animals	Negligible	Pervasive	Negligible	Ongoing	N/A
5.2	Gathering terrestrial plants					N/A
5.3	Logging & wood harvesting					N/A
5.4	Fishing & harvesting aquatic resources					N/A
6	Human intrusions & disturbance	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	
6.1	Recreational activities	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	Minor recreational (no motorized vehicles etc.); people tend to stay on trails
6.2	War, civil unrest & military exercises					N/A
6.3	Work & other activities					N/A
7	Natural system modifications	Low	Small (1-10%)	Extreme - Serious (31-100%)	Moderate (Possibly in the short term, < 10 yrs)	
7.1	Fire & fire suppression		Unknown	Unknown	Unknown	Undetermined what the threat is - fire or suppression
7.2	Dams & water management/use					N/A
7.3	Other ecosystem modifications	Low	Small (1-10%)	Extreme - Serious (31-100%)	Moderate (Possibly in the short term, < 10 yrs)	Site 2 Dallas Road Bluffs restoration, although activities undetermined at present.
8	Invasive & other problematic species & genes	Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	
8.1	Invasive non-native/alien species	Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	All sites have non-native species; it is unknown how these species affect beetle populations.
8.2	Problematic native species					Fire suppression section
8.3	Introduced genetic material					N/A
9	Pollution	Medium - Low	Restricted (11-30%)	Moderate - Slight (1-30%)	High (Continuing)	
9.1	Household sewage & urban waste water					N/A
9.2	Industrial & military effluents					N/A

	Threat	Impact (calculated)	Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
9.3	Agricultural & forestry effluents	Medium - Low	Restricted (11-30%)	Moderate - Slight (1-30%)	High (Continuing)	Pesticide runoff, cosmetic pesticides in unchecked habitat, herbicide use within agricultural areas. (Dallas Road by hand; Boundary Bay area lots); high uncertainty in severity, there is likely an impact
9.4	Garbage & solid waste					N/A
9.5	Air-borne pollutants					N/A
9.6	Excess energy					N/A
10	Geological events	Unknown	Unknown	Extreme (71-100%)	Unknown	
10.1	Volcanoes					N/A
10.2	Earthquakes/ tsunamis	Unknown	Unknown	Extreme (71-100%)	Unknown	
10.3	Avalanches/ landslides					N/A
11	Climate change & severe weather	Unknown	Pervasive (71-100%)	Unknown	Moderate (Possibly in the short term, < 10 yrs)	
11.1	Habitat shifting & alteration	Not a Threat (in the assessed timeframe)	Large (31-70%)	Extreme (71-100%)	Low (Possibly in the long term, >10 yrs)	sea level rise
11.2	Droughts	Not a Threat (in the assessed timeframe)	Pervasive (71-100%)	Unknown	Low (Possibly in the long term, >10 yrs)	N/A
11.3	Temperature extremes					N/A
11.4	Storms & flooding	Unknown	Pervasive (71-100%)	Unknown	Moderate (Possibly in the short term, < 10 yrs)	Given the location of current known occurrences, it is likely that the species can survive some periodic inundation

[a] Impact – The degree to which a species is observed, inferred, or suspected to be directly or indirectly threatened in the area of interest. The impact of each stress is based on Severity and Scope rating and considers only present and future threats. Threat impact reflects a reduction of a species population or decline/degradation of the area of an ecosystem.

[e] Sites – See Table 1 for site names.

Table 5. Threats to Audouin's Night-stalking Tiger Beetle sites. Sites with * have vague collection information, applicable threats apply to potential sites within this general region.

Threat	Site 1 Lochside Trail	Site 2 Dallas Road	Site 3 Blackie Spit Surrey Municipal Park	Site 4 Boundary Bay (near Airport)	Site 5 Boundary Bay (72nd Street access)	Site 6 Mud Bay Surrey Municipal Park	Site 7* Tod Inlet	Site 8* White Rock	Site 9* Elgin
Potential Habitat	Along a highly used walk/bike way surrounded by urban housing.	Habitat adjacent to ocean, in clay banks within a well-used municipal park, much illegal camping and campfires along shoreline.	Habitat adjacent to ocean, within a well-used municipal park	Site is within a municipal airport; potential habitat will remain open as the airport is actively used; expansion possible but not likely in short-term.	Habitat adjacent to ocean, within a well-used municipal park	Habitat adjacent to ocean, within a well-used municipal park	Habitat adjacent to seawater, shoreline habitat is adjacent to long-ago developed housing and larger lots with natural habitats.	Collection site unknown; but White Rock beach areas is a long-ago developed residential area, beach habitat is highly used throughout all times of the year.	Collection site unknown; but Elgin is a long-ago developed residential area of south Surrey, with large lots and natural vegetation; some beach areas are highly used in summer months
1.1 Housing & urban areas	Adjacent habitats subject to development	-	-	Adjacent habitats subject to development	Adjacent habitats subject to development	Adjacent habitats subject to development	Adjacent habitats subject to development	Adjacent habitats subject to development	Adjacent habitats subject to development
1.2 Commercial & industrial areas	-	-	-	Adjacent habitats subject to development	Adjacent habitats subject to development	Adjacent habitats subject to development	Adjacent habitats subject to development	-	Adjacent habitats subject to development
1.3 Tourism & recreation areas	Trail maintenance activities	Trail maintenance activities	Trail maintenance activities	-	Trail maintenance activities	Trail maintenance activities	-	Trail maintenance activities; likely habitat is high-use beach areas	Trail maintenance activities; likely habitat is high-use beach areas
2.1 Annual & perennial non-timber crops	-	-	Adjacent agricultural fields with potential habitat (unchecked)	Adjacent agricultural fields with potential habitat (unchecked)	Adjacent agricultural fields with potential habitat (unchecked)	Adjacent agricultural fields with potential habitat (unchecked)	Adjacent agricultural fields with potential habitat (unchecked)	-	Adjacent agricultural fields with potential habitat (unchecked)
2.2 Wood & pulp plantations	-	-	-	-	-	-	-	-	-
2.3 Livestock farming & ranching	-	-	-	-	-	-	-	-	-
2.4 Marine & freshwater aquaculture	-	-	-	-	-	-	-	-	-
3.1 Oil & gas drilling	-	-	-	-	-	-	-	-	-
3.2 Mining & quarrying	-	-	-	-	-	-	-	-	-
3.3 Renewable energy	-	-	-	-	-	-	-	-	-
4.1 Roads & railroads	-	-	-	Road widening and maintenance possible	-	-	Road widening and maintenance possible	Road widening and maintenance possible	-
4.2 Utility & service lines	-	-	-	-	-	-	-	-	-
4.3 Shipping lanes	-	-	-	-	-	-	-	-	-
4.4 Flight paths	-	-	-	-	-	-	-	-	-

Threat	Site 1 Lochside Trail	Site 2 Dallas Road	Site 3 Blackie Spit Surrey Municipal Park	Site 4 Boundary Bay (near Airport)	Site 5 Boundary Bay (72nd Street access)	Site 6 Mud Bay Surrey Municipal Park	Site 7* Tod Inlet	Site 8* White Rock	Site 9* Elgin
5.1 Hunting & collecting terrestrial animals	-	-	-	-	-	-	-	-	-
5.2 Gathering terrestrial plants	-	-	-	-	-	-	-	-	-
5.3 Logging & wood harvesting	-	-	-	-	-	-	-	-	-
5.4 Fishing & harvesting aquatic resources	-	-	-	-	-	-	-	-	-
6.1 Recreational activities	-	-	-	-	-	-	-	-	-
6.2 War, civil unrest & military exercises	-	-	-	-	-	-	-	-	-
6.3 Work & other activities	-	-	-	-	-	-	-	-	-
7.1 Fire & fire suppression	Fire and fire suppression throughout the area	Fire and fire suppression throughout the area	Fire and fire suppression throughout the area	Fire and fire suppression throughout the area	Fire and fire suppression throughout the area	Fire and fire suppression throughout the area	Fire and fire suppression throughout the area	Fire and fire suppression throughout the area	Fire and fire suppression throughout the area
7.2 Dams & water management/ use	-	-	-	-	-	-	-	-	-
7.3 Other ecosystem modifications	-	-	-	-	-	-	-	-	-
8.1 Invasive non-native/alien species	Invasive plants and invertebrates; severity and timing differ between sites	Invasive plants and invertebrates; severity and timing differ between sites	Invasive plants and invertebrates; severity and timing differ between sites	Invasive plants and invertebrates; severity and timing differ between sites	Invasive plants and invertebrates; severity and timing differ between sites	Invasive plants and invertebrates; severity and timing differ between sites	Invasive plants and invertebrates; severity and timing differ between sites	Invasive plants and invertebrates; severity and timing differ between sites	Invasive plants and invertebrates; severity and timing differ between sites
8.2 Problematic native species	-	-	-	-	-	-	-	-	-
8.3 Introduced genetic material	-	-	-	-	-	-	-	-	-
9.1 Household sewage & urban waste water	-	-	-	-	-	-	-	-	-
9.2 Industrial & military effluents	-	-	-	-	-	-	-	-	-

Threat	Site 1 Lochside Trail	Site 2 Dallas Road	Site 3 Blackie Spit Surrey Municipal Park	Site 4 Boundary Bay (near Airport)	Site 5 Boundary Bay (72nd Street access)	Site 6 Mud Bay Surrey Municipal Park	Site 7* Tod Inlet	Site 8* White Rock	Site 9* Elgin
9.3 Agricultural & forestry effluents	Herbicide use for trail maintenance	Herbicide use for trail maintenance	Herbicide use for trail maintenance; agricultural run-off	Herbicide use for trail maintenance; agricultural run-off	Herbicide use for trail maintenance; agricultural run-off	Herbicide use for trail maintenance; agricultural run-off	Herbicide use for trail maintenance; agricultural run-off	Herbicide use for right-of-way maintenance	Herbicide use for right-of-way maintenance
9.4 Garbage & solid waste	-	-	-	-	-	-	-	-	-
9.5 Air-borne pollutants	-	-	-	-	-	-	-	-	-
9.6 Excess energy	-	-	-	-	-	-	-	-	-
10.1 Volcanoes	-	-	-	-	-	-	-	-	-
10.2 Earthquakes/ tsunamis	Within tsunami zone	Within tsunami zone	Within tsunami zone	Within tsunami zone	Within tsunami zone	Within tsunami zone	Within tsunami zone	Within tsunami zone	Within tsunami zone
10.3 Avalanches/ landslides	-	-	-	-	-	-	-	-	-
11.1 Habitat shifting & alteration	-	-	-	-	-	-	-	-	-
11.2 Droughts	Potential droughts may impact larval sites	Potential droughts may impact larval sites	Potential droughts may impact larval sites	Potential droughts may impact larval sites	Potential droughts may impact larval sites	Potential droughts may impact larval sites	Potential droughts may impact larval sites	Potential droughts may impact larval sites	Potential droughts may impact larval sites
11.3 Temperature extremes	-	-	-	-	-	-	-	-	-
11.4 Storms & flooding	-	-	Potential flooding	Potential flooding	Potential flooding	Potential flooding	Some areas with potential flooding	Potential flooding	Potential flooding

Residential & Commercial Development (Medium) (Threat 1)

Housing and urban areas (1.1) **and** Commercial and industrial areas (1.2)

Natural low elevation (< 10 m) flood plain habitats within 1 – 3 km of the seashore represent core habitats for the Audouin's Night-stalking Tiger Beetle and coincide with areas of high urban and agricultural land conversion. Few large, natural habitats remain within the core range of the Audouin's Night-stalking Tiger Beetle and most are in private ownership (local government or private). Activities associated with urban developments, specifically those that include clearing or removing habitat and/or altering natural hydrological patterns that result in habitat conditions that are too dry or wet for prolonged periods, can impact the microhabitat and overall open forest and meadow habitat necessary to sustain populations of this beetle.

Each municipal government has an Official Community Plan with specific areas designated for future housing and commercial development to service the increase in human population. For large-scale developments, the *Local Government Act* requires a private landowner who is subdividing their property to dedicate 5% of the land subject to subdivision as a park or to pay cash in lieu of the land. However, this does not necessarily provide habitat for species at risk. Some municipalities have Environmentally Sensitive Development Permit areas and can direct development away from these sensitive areas with high ecological values (e.g., habitat for species at risk). However, if this is a gap in a municipality's Official Community Plan, then ecosystem values such as the Audouin's Night-stalking Tiger Beetle do not get protected.

Within 5 km of the seashore and within the past five years, there have been at least 15 urban housing developments in White Rock, one in south Surrey (most land surrounding known beetle sites is agricultural) and one in Tsawwassen (see Greater Vancouver Real Estate 2012). Most of this development has been within privately owned natural land, and in some cases agricultural land. One additional proposed 537-hectare mixed-use development in Tsawwassen is adjacent to Boundary Bay Regional Park (site 5) and proposes different areas for natural recreation, commercial and housing zones (Imagine Southlands 2012).

Tourism and recreational areas (1.3)

The demand for tourism and recreational areas within the Lower Fraser Valley and the greater Victoria area has increased substantially within the past decade. Natural areas continue to be developed into golf courses, campgrounds, parks, and recreation facilities. This threat applies to small areas of habitat within recreational areas and surrounding habitat adjacent to eight Audouin's Night-stalking Tiger Beetle sites (1, 2, 3, 5, 6, 7, 8, 9). Within existing parks, as well as regional and municipal properties, habitat conservation and recreational development potentially conflicts with Audouin's Night-stalking Tiger Beetle conservation. Potential threats include construction of new trails and rights-of-way within highly used Metro Vancouver parks such as Boundary Bay Regional Park. Expansion of recreational areas also increases the frequency of road and trail building (see Threat 8.1).

Pollution (Low-Medium) (Threat 9)

Agricultural and forestry effluents (9.3)

The use of pesticides, especially those aimed at ground vegetation, has potential to harm Audouin's Night-stalking Tiger Beetle populations by directly killing individual eggs and larvae. Overall, the general use of herbicides within parks and protected areas is diminishing due to municipal and regional bylaws that limit the use of these chemicals (e.g., City of Richmond). Provincial initiatives that consider the ban on home use of pesticides for cosmetic purposes throughout B.C. are ongoing (Nagel 2011). However, pesticide bans are controversial in some municipalities (e.g., Cassidy 2011).

The Audouin's Night-stalking Tiger Beetle has been recorded from brushy, low-lying vegetation in forest and trail edge habitats at five sites adjacent to well-used recreational trails within urban parks (site 1, 2, 3, 5, 6). Spraying herbicides to control road or trail-side vegetation likely harms beetles within these verges, and the cumulative and persistent effects of herbicides within these environments may lead to long-term declines in beetle numbers. It is unclear how extensive this practice was (or is currently) within the range of the Audouin's Night-stalking Tiger Beetle.

It is possible that agricultural runoff could impact the Audouin's Night-stalking Tiger Beetle. The beetle has been found adjacent to agricultural and urban runoff areas (sites 1, 2, 4, 5, 6 and likely 7), but the overall impact to the species is unknown. Increasing blueberry acreage throughout the Fraser Valley includes many sites potentially adjacent to potential Audouin's Night-stalking Tiger Beetle habitat. Concern for fruit pests such as Spotted Wing Drosophila (*Drosophila suzukii* (Matsamura)) has resulted in intensive spraying of hedgerows, riparian areas and other vegetation that includes wild fruits capable of serving as refuge for the pests. This may in turn be a problem for edge species such as the Audouin's Night-stalking Tiger Beetle. Pesticides and fertilizers threaten this species in much of its remaining suitable habitat, particularly that adjacent to the urban/agricultural interface.

Agriculture and Aquaculture (Low) (Threat 2)

Annual and perennial non-timber crops (2.1)

Old fields (e.g., fallow agricultural areas that do not have crops and may not have grown crops for over ten years; areas that have partially grown with native vegetation), meadows and open forest habitat within the Agricultural Land Reserve are subject to clearing and conversion. In some cases, landowners/managers may clear land in anticipation of future agricultural development, although no actual crops, grazing or agricultural practices will occur on the land for a number of years. At present, there is no environmental assessment required for species at risk presence surveys prior to the clearing of land for agricultural purposes. This is a potential threat at many agricultural sites within the Lower Fraser Valley with verges of natural habitat surrounding the agricultural fields (sites 3, 4, 5, 7, 6 and 9). The threat also applies to remnant areas of unchecked habitat (e.g., ditch side verges, crop verges and the perimeter of agricultural fields) where Audouin's Night-stalking Tiger Beetles may remain in small habitat patches. In the past decade there has been an increase in greenhouse construction on land zoned as Agricultural Land Reserve, which contributes to loss of old field and meadow ecosystem habitat. Approximately 90% of greenhouses in B.C. are in the Lower Fraser Valley (B.C. Ministry of Agriculture 2012).

Livestock farming and ranching (2.3)

Detrimental impacts to Audouin's Night-stalking Tiger Beetle habitat from livestock grazing may apply to habitats surrounding extant sites. Livestock grazing can be detrimental to tiger beetle populations (Knisley 2011). Trampling of sensitive forest and meadow areas is often a result of livestock congregating adjacent to watercourses or near preferential vegetation, and there would be direct mortality caused by trampling of larval development sites and habitat as well as consumption of herbaceous vegetation otherwise used as cover by Audouin's Night-stalking Tiger Beetle adults. This threat may apply to habitats surrounding sites 3, 4, 5, 6 and 7.

It is possible that the beetle may be able to tolerate moderate livestock grazing, as long as larval sites are not heavily compacted. In Washington State, two recorded Audouin's Night-stalking Tiger Beetle sites are known to have historical grazing. Mima Mounds Prairie was heavily grazed from 1905 – 1967 and Glacial Heritage has been partially grazed (Maynard 2007). More study is required.

Human Intrusions and Disturbance (Low) (Threat 6)

Recreational activities (6.1)

Recreational activities that impact habitat are ongoing within at least seven of the nine Audouin's Night-stalking Tiger Beetle sites (1, 2, 3, 5, 6, 8* and 9*). Activities include hiking (e.g., Sites 3, 5, 6, 8*), foot and bicycle traffic (e.g., Site 1), horseback riding (habitat surrounding Site 3, 5, 7) and trail bikes (e.g., potential habitat on private land, all sites), especially off-trail bikes. Such activities can result in degradation of habitat quality through soil compaction of larval burrow sites and can also cause accidental mortality especially along trail edges. Sites 3 and 9* are high use recreational areas, especially for sunbathing and beach use during summer months.

Effects from recreational activities can be pronounced in areas where the species is restricted to small habitat patches (e.g., Site 1, 7). For example, inadvertent trampling of the site could result in significant mortality, especially during spring breeding periods. Recreational activities may also increase the spread of introduced species (see Threat 8.1). Recreational use of trails for horseback riding also likely impacts habitat (e.g., trampling of trails/edges and defecation, which increases the spread of fungus, seeds, etc.).

Natural System Modifications (Low) (Threat 7)

Fire and fire suppression (7.1)

The threat of fire is present throughout the entire range of the Audouin's Night-stalking Tiger Beetle, particularly Garry Oak habitats, within large tracts of agricultural and open meadow habitat, roadside verges and areas adjacent to rights-of-way that could act as population dispersal corridors and refuges and in recreational areas. Human activities that increase the threat of fire include discarded cigarettes and illegal campfires within recreational areas. Audouin's Night-stalking Tiger Beetle habitats remain moist and wet throughout the year, but the threat of fires increases substantially in July through September. All Audouin's Night-stalking Tiger Beetle sites are threatened by fire; however, not at the same time. The severity and timing of fire is unknown.

Fire is a threat, but fire suppression is also a contributing factor to natural succession and the decline of quality habitat. Primarily, natural succession reduces the area and quality of exposed sandy areas where Audouin's Night-stalking Tiger Beetles can lay eggs and developing larvae can spend up to two years within tunnels.

Other ecosystem modifications (7.3)

Mowing and cutting of vegetation within sites (for right-of-way maintenance and sometimes as a form of fire suppression) may affect foraging and larval tunnel sites for Audouin's Night-stalking Tiger Beetles. Removal of vegetation may decrease available substrate moisture retention (applicable to larvae within larval tunnels) leading to an increase of dehydration stress to individuals, as well as direct mortality of individuals at all life stages. This threat is present at the urban interface; roadsides, trails and other right-of-ways; and agricultural areas.

Invasive and Other Problematic Species (Unknown) (Threat 8)

Invasive non-native/alien species (8.1)

The threat of invasive species is present at all sites; however, there is some uncertainty as to the level of impact of this threat. All sites have introduced Himalayan Blackberry (*Rubus armeniacus*) and other non-native plants, introduced gastropods, earthworms and various introduced carabid beetles, although the scope of introduction and suite of species present is not fully known.

Information on invasive plant species is available for Boundary Bay Regional Park (site 5). Ecosystem mapping information showed a 41% decline of wet and dry old-field habitat within the park from 1996 to 2008 as a result of non-native invasive plant species (Coulthard 2008; Metro Vancouver 2009).

Sparsely vegetated plant communities are susceptible to colonization by invasive plants such as Scotch Broom and exotic grasses such as Cheatgrass (*Bromus tectorum* L.), European Beachgrass (*Ammophila arenaria* L.), Orchardgrass (*Dactylis glomerata* L), Common Velvetgrass (*Holcus lanatus* L.), Soft Brome (*Bromus hordeaceus* L.), and Rat-tail Fescue (*Vulpia myuros* L.). Annual Vernalgrass (*Anthoxanthum odoratum* L.) may be accelerating vegetation stabilization. English Ivy (*Hedera helix* L.) is known to spread and displace the native vegetation on forest floors. Scotch broom is known to fix nitrogen in low fertility sand soils and rapidly take over sand-dominated areas (Parker 2002), and is more of a threat at sites 1 and 2 in greater Victoria.

Geological Events (Unknown) (Threat 10)

Earthquakes/tsunamis (10.2)

All extant Audouin's Night-stalking Tiger Beetle sites in B.C. are in close proximity (< 3 km) to the marine shoreline and could potentially be impacted from earthquakes or tsunamis. This region of the country has the highest threat of earthquake and tsunami in Canada. Although the threat has the potential of being severe, the timing of such events is unknown.

Climate Change and Severe Weather (Unknown) (Threat 11)

Storms and flooding (11.4)

All Audouin's Night-stalking Tiger Beetle sites in B.C. are within 3 km of the shoreline and sites 3, 4, 5 and 6 may be flooded by seawater during storm surges. The effect of temporary flooding is perhaps mitigated by the fact that most storm surges occur in winter when the larval burrows are sealed. Much of the species' potential habitat in the Lower Mainland (< 1 km from shoreline as suggested to be the inland extent of most records [van den Berghe 1990]) is within the potential flood zone of the Fraser River (B.C. Ministry of Environment 2011b). The greatest vulnerability to flood risk within the range of the Audouin's Night-stalking Tiger Beetle includes Tsawwassen (Kangasniemi 2009), White Rock and lower elevation areas of Surrey (Fraser Basin Council 2011). Sites in the Victoria area are not subject to flooding.

The Lower Fraser Valley has experienced major floods: the largest in 1894 and the second largest in 1948 (B.C. Ministry of Environment 2011b). Within the next 50 years there is a one-in-three prediction that a flood of similar magnitude will occur within the Lower Fraser Valley (Fraser Basin Council 2011). Forseth (2012) summarizes flooding threats for the Boundary Bay area. Storms posing the greatest flood threat are a combination of high tides and storm surges. The most recent of these storms (February 4, 2006) raised a 5.5 m high tide by an additional 91 cm surge, causing extensive sea water inundation in the Boundary Bay area and flooding Audouin's Night-stalking Tiger Beetle habitat within this area.

Sea level rise is considered a threat to the Lower Mainland (Forseth 2012; Thomson *et al.* 2008; Kangasniemi 2009). The overall impact to beetle populations is unknown, but if frequency and severity of storms and flooding increases, impacts may cause an overall decline to populations.

Limiting Factors for the Audouin's Night-stalking Tiger Beetle

Dispersal ability:

The Audouin's Night-stalking Tiger Beetle is robust, with strong legs and ability to crawl distances. Yet the species is flightless and the overall dispersal ability is likely poor. It is unclear how much spatial area (habitat) is required to sustain a population within a site or habitat patch.

Prey:

The main factor thought to limit tiger beetle populations (in general) is food availability (Pearson and Vogler 2001). The Audouin's Night-stalking Tiger Beetle feeds on ants and centipedes (Maser 1977a; Larochelle and Lariviere 2001), and likely other invertebrates, such as millipedes as predated upon by the Greater Night-stalking Tiger Beetle (LaBonte and Johnson 1988).

Egg and larval development sites (including soil type and mineral composition):

Soil mineral content (including magnesium and calcium), pH and soil type may play an important factor in the Audouin's Night-stalking Tiger Beetle's microhabitat preference for egg-laying and larval development. Although not studied (in detail) for the Audouin's Night-stalking Tiger Beetle, these factors are known to affect habitat preferences in other tiger beetles (Pearson *et al.* 2005) and *Omus* specifically (van den Berghe 1990).

Native predators:

Potential native predators include shrews (Maser 1973; Maser and Hooven 1974; Larochelle and Lariviere 2001). Three shrew species range within the same habitat as the Audouin's Night-stalking Tiger Beetle in Canada: the Pacific Water Shrew (*S. bendirii* (Merriam)), Red-listed in B.C.; the Olympic Shrew (*S. rohweri.*), Red-listed in B.C.; and the Trowbridge's Shrew (*S. trowbridgii* Baird), Blue-listed in B.C. (British Columbia Conservation Data Centre 2013). These and other predators live in similar habitats, and experience similar threats, as the Audouin's Night-stalking Tiger Beetle, although there is no known obligate association. Concentration of predators in small habitat patches where little escape cover exists will likely increase predation rates. Competition and predation as a limiting factor may become more of a threat when combined with threats from introduced species and development pressures.

Larval burrow substrate compaction:

Larvae spend up to three years within larval tunnels, and are thus at risk of flooding, soil compaction, and other forms of disturbance. Maser (1977a) recorded the mortality of one individual within a road bank (in Oregon), suggesting the individual perished due to the hardness of the soil and the individual's inability to dig out of its pupal chamber.

Number of Locations

At present there are six confirmed and three unconfirmed extant sites for the Audouin's Night-stalking Tiger Beetle, occupying habitat spanning at least seven different landowners. All sites are privately owned, including local government land, which is considered private land in B.C. If each separate parcel of land is considered a location (based on the threat of development), then the number of locations for the Audouin's Night-stalking Tiger Beetle in Canada is nine. This includes the vague site collection information for Tod Inlet (site 7), White Rock (site 8) and Elgin (site 9). The historical sites with vague collection information in Saanich (site 10) and the Victoria Highlands District (site 11) (Table 1) are not included (see **Canadian Range**).

If storm surges and flooding of the coastline habitats is considered the primary threat to Audouin's Night-stalking Tiger Beetle, then the total number of locations is five. This calculation was based on combining all sites along the Boundary Bay area (sites 3, 4, 5, 6 and 9) into one location based on the close proximity and potential for one storm event to impact all five sites. Sites 1, 2, 7, and 8 result in one location each.

PROTECTION, STATUS AND RANKS

Legal Protection and Status

The Audouin's Night-stalking Tiger Beetle is not currently protected by provincial or federal laws. The species is not listed under the provincial *Forest and Range Practises Act* (Province of British Columbia 2002).

Non-Legal Status and Ranks

In B.C., the Audouin's Night-stalking Tiger Beetle has a conservation status rank of S1 (critically imperiled) and is Red-listed (British Columbia Conservation Data Centre 2013); it is ranked N1 (critically imperiled) in Canada and G5 (secure) rangewide (NatureServe 2013). In Washington State and Oregon the species has a conservation status rank of S5 (secure) and is not ranked in California (NatureServe 2013).

The Audouin's Night-stalking Tiger Beetle is a priority one species (highest priority) under goal three (maintain the diversity of native species and ecosystems) of the B.C. Conservation Framework (B.C. Ministry of Environment 2011b). Provincial staff responsible for species at risk within the range of the Audouin's Night-stalking Tiger Beetle are aware of the species' habitat requirements and advise other staff to look out for possible new occurrences (Chatwin pers. comm. 2012; Hirner, pers. comm. 2012; McClaren pers. comm. 2012; Robbins pers. comm. 2013).

Non-government conservation organizations, such as the South Coast Conservation Program (Robbins pers. comm. 2013; Zevit pers. comm. 2012), Delta Farmland and Wildlife Trust (Bradbeer pers. comm. 2012) and Fraser Valley Conservancy (MacMillan pers. comm. 2012), and Garry Oak Ecosystems Recovery Team (Junck pers. comm. 2013) outline stewardship opportunities and work with private landowners towards protecting invertebrate species at risk habitat on private lands. These organizations are likely to become more involved with stewardship work for the Audouin's Night-stalking Tiger Beetle in the future now that the profile of this rare beetle has been raised.

Habitat Protection and Ownership

Most land within the range of the Audouin's Night-stalking Tiger Beetle is privately owned (Table 1). Ownership is by individuals (e.g., farms or rural properties), land developers (e.g., with future plans for urban housing or industrial real estate uses), or local governments (e.g., watersheds and natural areas or future urban/commercial real estate development).

The Audouin's Night-stalking Tiger Beetle is not known from federal property, despite pitfall trapping within federal properties within the known range of the species such as Gulf Islands National Park Reserve, Alaksen National Wildlife Area, and the Canadian Forces Ammunition Depot at Rocky Point.

There is no legislative protection specifically for Audouin's Night-stalking Tiger Beetle habitat on provincially or privately owned lands in B.C. The species has been recorded from three local government parks within the Lower Fraser Valley (Site 3 Blackie Spit Surrey Park, Site 5 Boundary Bay Regional Park and Site 6 Mud Bay Municipal Park), one park in Victoria (Site 2 Beacon Hill Municipal Park) and along a regional greenway in greater Victoria (Site 1 Galloping Goose Capital Regional District Trail). Metro Vancouver (regional district) (Merkens pers. comm. 2012) and Surrey Municipal Parks (Chan pers. comm. 2012) land managers are aware of the Audouin's Night-stalking Tiger Beetle and are working to incorporate best management practices into park maintenance planning within parks where the species has been recorded.

Proposed urban development requires various types of permitting under local, provincial and federal government policy and legislation. Local government bylaws that protect environmental values are different among the municipalities known to have Audouin's Night-stalking Tiger Beetle sites and potential habitat (White Rock, Surrey, Delta, Tsawwassen, Richmond, Victoria, and Saanich). There are no local (municipal and regional) government bylaws that specifically protect Audouin's Night-stalking Tiger Beetle individuals or habitat (see Threat 1).

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Woods, B. British Columbia Ministry of Environment, Victoria, B.C.

INFORMATION SOURCES

Acorn, J. 2001. Tiger beetles of Alberta. The University of Alberta Press, Edmonton, AB. 120pp.

Agee, J.K. 1993. Fire Ecology of Pacific Northwest Forests. Island Press, Washington, DC and Covelo, CA.

Annschild, R. 2012. *Verbal correspondence to J. Heron.* February 2011. Conservation Director, Salt Spring Island Conservancy, Salt Spring Island, British Columbia.

Bergdahl, J. 2011 – 2012. *Email correspondence to J. Heron and S. Cannings.* Conservation Biology Centre, Spokane, Washington State.

Berghe, E.P. van den. 1990. On the habits and habitat of *Omus* (Coleoptera: Cicindelidae). Cicindela 22(4):61 - 88.

Bianchini, C. 2012. *Verbal correspondence to J. Heron.* February 2013. Conservation Biologist, Bianchini Biological Services, Delta, British Columbia.

Bland, R. G. 1978. How to Know the Insects, 3rd Edition. Dubuque, Iowa, Wm. C. Brown Company Publishers.

British Columbia Conservation Data Centre. 2012. BC Species and Ecosystems Explorer. British Columbia Ministry of Environment, Victoria, British Columbia. Web site: http://a100.gov.bc.ca/pub/eswp/ [accessed September 19, 2011].

British Columbia Ministry of Agriculture. 2012. Greenhouse Vegetables webpage. http://www.agf.gov.bc.ca/aboutind/products/plant/grnh_veg.htm [Accessed December 3, 2012].

British Columbia Ministry of Environment. 2011a. Environmental Stewardship Division. Conservation Framework. Web site: http://www.env.gov.bc.ca/conservationframework/ [accessed June 15, 2012].

British Columbia Ministry of Environment. 2011b. Water Stewardship Division. Index of designated flood plain areas by region. http://www.env.gov.bc.ca/wsd/data_searches/fpm/reports/region2.html [accessed June 15, 2012].

Burdick, D.J., and Wasbauer, M.S. 1959. Biology of *Methocha californica* Westwood (Hymenoptera: Tiphiidae). Wasmann Journal of Biology 17:75 – 88. Department of Environmental Conservation.

Bradbeer. 2012. *Verbal correspondence with J. Heron.* Delta Farmland and Wildlife Trust, Delta, BC

Canadian Wildlife Service and British Columbia Ministry of Environment. 2002. Report: Sensitive Ecosystems Inventory (SEI): East Vancouver Island and the Gulf Islands (includes 2002 Disturbance Mapping) http://www.env.gov.bc.ca/sei/van_gulf/publications.html

Cassidy, A. 2011. Pesticide ban too political [May 6, 2011 edition]. Coquitlam Now Abbotsford-Mission Times. Web site: http://www.abbotsfordtimes.com/news/Pesticide+political/4738144/story.html [accessed November 20, 2011].

Chan, N. 2012. *Email correspondence with J. Heron.* City of Surrey Parks and Recreation, Surrey, BC

Chatwin, T. 2012. *Verbal correspondence to J. Heron.* February 2012. Species At Risk Biologist, British Columbia Ministry of Forests, Lands and Natural Resource Operations (Region 1), Nanaimo, British Columbia.

Conservation Measures Partnership. 2006. Threats Taxonomy, how do we define direct threats? Web site: http://www.conservationmeasures.org/initiatives/threats-actions-taxonomies/threats-taxonomy/ [accessed November 19, 2011].

Comstock, J. H. 1920. An Introduction to Entomology. Binghamton, New York, Vail-Ballou Press.

Copley, C. 2012. *Verbal correspondence to J. Heron.* October 2012. Entomology Collections Manager, Royal B.C. Museum, Victoria, British Columbia.

COSEWIC. 2011. Guidelines for recognizing designatable units. Web site: http://www.cosewic.gc.ca/eng/sct2/sct2_5_e.cfm [accessed June 15, 2012].

COSEWIC 2012. www.cosewic.gc.ca [accessed December 9, 2012].

Coulthard, M. 2008. Old-field management/Terrain Ecosystem Mapping – Boundary Bay Regional Park. Prepared for Metro Vancouver Regional Parks. 30pp.

Craig, K. 1993. Masters of Science thesis, University of British Columbia.

Crowe, T. 2011. *Verbal correspondence to J. Heron.* January 2011. Conservation Biologist, Galiano Island Conservancy, Galiano Island, British Columbia

Daubenmire, R. 1968. Ecology of fire in grasslands. Advances in Ecological Research 5:209-259.

Dimmock, G., and B. P. Mann. 1879. The anatomy of *Amblychila cylindriformis* Say. Psyche 2(61 – 62):233–246.

Dunn, M. 2011. *Verbal correspondence to J. Heron.* October 2012. Conservation Biologist, Mayne Island Conservancy, Mayne Island, British Columbia.

Erickson, W. 1993. Garry Oak Ecosystems. Ecosystems in British Columbia at Risk Series. Conservation Data Centre, Wildlife Branch. Victoria: British Columbia Ministry of Environment, Lands and Parks. 6pp.

Erickson, W. 1995. Classification and interpretation of Garry Oak (*Quercus garryana*) plant communities and ecosystems in southwestern British Columbia. MSc. Thesis. Department of Geography, University of Victoria, Victoria, British Columbia. 307 pp.

Forseth, P. 2012. Adaptation to sea level rise in Metro Vancouver: a review of literature for historic sea level flooding and projected sea level rise in Metro Vancouver. The Adaptation to Climate Change Team: Session #6. Adaptation to sea level rise. http://act-adapt.org/wp-content/uploads/2011/06/ACT_SLR_Literature-Review_250212.pdf [accessed November 27, 2012]

Fraser Basin Council. 2011. Flood Hazard Management on the Fraser River. Web site: http://www.fraserbasin.bc.ca/programs/flood.html [accessed June 15, 2012].

Freitag, R. 1999. Catalogue of the tiger beetles of Canada and the United States. NRC Research Press, Ottawa, Ontario. 195 pp.

Fuchs, M. 2000. Towards a recovery strategy for Garry Oaks and associated ecosystems in Canada: Ecological Assessment and Literature Review. Environment Canada, Canadian Wildlife Service. 106 pp.

Garry Oak Ecosystems Recovery Team. 2012. www.goert.ca [accessed September 23, 2012].

Greater Vancouver Real Estate. 2012. Greater Vancouver Regional Housing Development Interactive Map. Web site: http://www.gvrd.com/real_estate_new_housing/index.html [accessed October 19, 2011].

Hamilton, C.C. 1925. Studies on the morphology, taxonomy and ecology of the larvae of Holarctic tiger beetles (Family Cicindelidae). Proceedings of the United States Natural History Museum65: 1788 – 1792.

Hebda, R.J. 2004. Paleoecology, climate change and forecasting the future of species at risk. In Lofroth, E.C. and T.D. Hooper (editors). Proceedings of the Species at Risk 2004. Pathways to Recovery, Victoria, British Columbia.

Henderson, S. 2008. Taxonomy, form or function: evaluating three approaches to using Carabid beetles (Coleoptera: Carabidae) as bioindicators in a coastal forest. Masters of Science thesis, University of Northern British Columbia, Prince George, British Columbia. 88pp.

Heron, J. 2007. Personal data collected as part of a survey of terrestrial and freshwater arthropods in the Gulf Islands National Park Reserve: Saturna, Cabbage and Tumbo Islands. British Columbia Ministry of Environment, Vancouver, BC.

Heron, J. 2010. Personal data collected as part of a pitfall trapping survey within the lower mainland. British Columbia Ministry of Environment, Vancouver, BC.

Heron, J. 2012. Personal data collected as part of the pitfall trapping completed during the preparation of this status report, within the lower mainland. British Columbia Ministry of Environment, Vancouver, BC.

Hirner, J. 2012. *Verbal correspondence to J. Heron.* February 2012. B.C. Ministry of Environment, Parks and Protected Areas (Region 2), North Vancouver, British Columbia.

Hitchcock, C. Leo, A. Cronquist, M. Ownbey, J.W. Thompson. 1964. Vascular Plants of the Pacific Northwest. Part 2: Salicaceae to Saxifragaceae. University of Washington Press: Seattle, Washington. 597 pp.

Horn, W. 1915. Coleoptera Adephaga (family Carabidae, subfamily Cicindelinae). Pp. 1 – 486 in P. Wytsman, ed., Genera Insectorum. Brussels: Desmet-Vereneuil.

Imagine Southlands. 2012. http://www.imaginesouthlands.ca/southlands-overview [accessed October 28, 2012].

International Barcode of Life Project 2012. http://www.barcodeoflife.org/ [accessed January 11, 2013].

International Union for Conservation of Nature and Conservation Measures Partnership (IUCN and CMP). 2006. IUCN – CMP unified classification of direct threats, ver. 1.0 – June 2006. Gland, Switzerland. 17 pp. http://www.conservationmeasures.org/initiatives/threats-actions-taxonomies/threats-taxonomy. [accessed June 15, 2012].

International Union for the Conservation of Nature (IUCN). 2011. Guidelines for using the IUCN Red List categories and criteria. Version 9.0 (September). Prepared by the Standards and Petitions Subcommittee. Web site: www.iucnredlist.org/documents/RedListGuidelines.pdf [accessed June 15, 2012].

Junck, C. 2013. *Verbal correspondence to J. Heron.* May 2013. Outreach Specialist, Garry Oak Ecosystems Recovery Team, Victoria, BC.

Kangasniemi, B. 2009. Climate change impacts for the coastal B.C. Tsawwassen Area Plan Review Public Forum #3: Adapting to a Changing Climate. October 6, 2009. Climate Action Secretariat, B.C. Ministry of Environment. http://www.corp.delta.bc.ca/assets/CPD/PDF/public_forum_presentation_moe.pdf [accessed December 3, 2012].

Keller, I., and C. Largiader. 2003. Recent habitat fragmentation caused by major roads leads to reduction of gene flow and loss of genetic variability in ground beetles. Proc. Royal Society of London 270:417 – 423. http://rspb.royalsocietypublishing.org/content/270/1513/417.full.pdf [Accessed December 3, 2012].

Kirkby, J. and D. Cake. 2004. Tracking Ecosystem Loss on East Vancouver Island and the Gulf Islands: Recent Research and Application. In T.D. Hopper, Editor. Proceedings of the Species At Risk 2004 Pathways to Recovery Conference. March 2 – 6, 2004, Victoria, B.C. Species at Risk 2004 Pathways to Recovery Organizing Committee, Victoria, B.C. posted at http://www.llbc.leg.bc.ca/public/pubdocs/bcdocs/400484/kirkby_edited_final_jun_3.pdf [accessed December 3, 2012].

Klinkenberg, Rose. *Verbal correspondence to J. Heron.* October 2012. Data Manager, E-Fauna, Vancouver, British Columbia.

Knisley, C.B. 2011. Anthropogenic disturbances to rare tiger beetle habitats: benefits, risks and implications for conservation. Terrestrial Arthropod Reviews 4(2011): 41-61.

LaBonte, J.R. and P.J. Johnson. 1988. Millipede predation by *Omus dejeani* Reiche. Cicindela 20(3/4):53 - 54.

Larochelle, A., and M-C. Lariviere. 2001. Natural history of the tiger beetles of North America north of Mexico. Cicindela 33:41 – 122.

Lea, T. 2006. Historical Garry Oak Ecosystems of Vancouver Island, British Columbia, pre-European Contact to the Present. Davidsonia 17(2):34-50

Leffler, S.R. 1979. Tiger beetles of the Pacific Northwest (Coleoptera: Cicindelidae). Ph.D. dissertation. university of Washington, Seattle, Washington.

Leffler, S.R. 1985. The tiger beetle genus *Omus* Eschscholtz: larval characters and their implications. Cicindela 17(4):53-56.

Leffler, S., and D.L. Pearson. 1976. The tiger beetles of Washington. Cicindela 8:21-60.

Leng, C.W. 1902. Revision of the Cicindelidae of Boreal America. Transcriptions of the American Entomological Society 28:93 - 186.

MacMillan, S. 2012. *Email correspondence to J. Heron.* Fraser Valley Conservancy, Abbotsford, BC.

Maser, C. 1977a. Notes on *Omus audouini.* Cicindela 9: 47-49.

Maser, C. 1977b. Notes on *Omus dejeani*. Cicindela 9(2): 35.

Maser, C., and F.M. Beer. 1971. Notes on the daily activity of *Omus audouini* and *Omus dejeani.* Cicindela 3(3):51.

Maser, C. and E.F. Hooven 1974. Notes on the behavior and food habits of captive Pacific shrews, *Sorex pacificus pacificus.* Northwest Science 48:81-95.

Maser, C. 1973. Preliminary notes on the distribution, ecology and behavior of *Cicindela bellisssima* Leng. Cicindela 5(4):61–76.

Master, L., D. Faber-Langendoen, R. Bittman, G.A. Hammerson, B. Heidel, J. Nichols, L. Ramsay, and A. Tomaino. 2009. NatureServe conservation status assessments: factors for assessing extinction risk. NatureServe, Arlington, Virginia, USA. Web site: http://www.natureserve.org/publications/ConsStatusAssess_StatusFactors.pdf [accessed June 15, 2012].

Maynard, C. 2007. Ground beetles in three western Washington prairies and associated oak forests. Unpublished report. 16 pages. Available at http://w.southsoundprairies.org/documents/BeetlesonSouthSoundPrairiesbyMaynard.pdf [Accessed October 28, 2012].

McClaren, E. 2012. *Verbal correspondence to J. Heron.* October 2012. Conservation Specialist. B.C. Ministry of Environment, Parks and Protected Areas (Region 1), Black Creek, British Columbia.

McCoy, M. 2006. High resolution fire and vegetation history of Garry oak ecosystems in British Columbia. MSc Thesis. Simon Fraser University, Department of Biological Sciences, Burnaby, B.C. 75 pp.

McDonnell, Z. 2011. Email correspondence to J. Heron. September 2011. Wildlife Consultant, Surrey, British Columbia.

McLean, J.A., A.L. Behennah, and M.A. Fairbarns. 2009. Ground beetles (Coleoptera: Carabidae) associated with Garry Oak Ecosystems on Southern Vancouver Island, British Columbia. Journal of the Entomological Society of British Columbia 106:47–51. http://journal.entsocbc.ca/index.php/journal/article/view/27/25 [accessed September 30, 2012].

McLean and Li. 2009. Ground beetles (Coleoptera:Carabidae) of Stanley Park, Vancouver, British Columbia following the storms of December 2006. Journal of the Entomological Society of British Columbia Volume 106: 53-60

McPherson, G.R. 1997. Ecology and Management of North American Savannas. Univ. of Arizona Press, Tucson, AZ.

Merkens, M. 2012. *Verbal correspondence to J. Heron.* June 2012. Park Manager, Metro Vancouver, West Area Office, Vancouver, British Columbia.

Metro Vancouver. 2009. Draft Boundary Bay Regional Park Old-field Management Strategy. October 15, 2009. 18pp.

Nagel, J. 2011. B.C. law-makers eye blanket pesticide ban. Abbotsford News (July 7 2011). Web site: http://www.abbynews.com/news/125168478.html [accessed June 15, 2012].

NatureServe. 2013. NatureServe Explorer. Web site: http://www.natureserve.org/explorer/ [accessed September 12, 2013].

Page, N., P. Lilley, I.J. Walker, and R.G. Vennesland. 2011. Status report on coastal sand ecosystems in British Columbia. Report prepared for the Coastal Sand Ecosystems Recovery Team. vii + 83 pp. Available at http://www.coastalsandecosystems.ca/docs/CSE-Status-Report-2011.pdf [Accessed October 28, 2012].

Parker, I.M. 2002. Invasion Ecology. In: McGraw-Hill Encyclopedia of Science and Technology, 9th Edition, Volume 9.

Parkinson, L., and J. Heron. 2010. Surveys for two invertebrate species at risk in southwestern British Columbia: Audouin's Night-stalking Tiger Beetle (*Omus audouini*) and Oregon Forest Snail (*Allogona townsendiana*). B.C. Ministry of Environment, Terrestrial Conservation Science Section, Vancouver, B. C. 182 pp.

Pearson, D.L. and F. Cassola. 1992. World-wide species richness patterns of Tiger Beetles (Coleoptera: Cicindelidae): indicator taxon for biodiversity and conservation studies. Conservation Biology 6(3):376 – 391.

Pearson, D.L., Knisley, C.B., and Kazilek, C.J. 2006. A field guide to the tiger beetles of the United States and Canada: identification, natural history, and distribution of the Cicindelidae. Oxford University Press, New York, New York. vi + 227 pp.

Pearson, D.L., and Vogler, A.P. 2001. Tiger beetles: the evolution, ecology, and diversity of the cicindelids. Cornell University Press, Ithaca, New York. xiii + 333 pp.

Province of British Columbia. 1982. Wildlife Act [RSBC 1996] c. 488. Queen's Printer, Victoria, British Columbia. Web site: http://www.bclaws.ca/EPLibraries/bclaws_new/document/ID/freeside/00_96488_01 [accessed May 31, 2012].

Province of British Columbia. 2002. Forest and Range Practices Act [RSBC 2002] c. 69. Queen's Printer, Victoria, British Columbia. Web site: <http://www.for.gov.bc.ca/tasb/legsregs/http://www.bclaws.ca/EPLibraries/bclaws_new/document/ID/freeside/00_02069_01 [accessed May 31, 2012].

Richardson, R.K. 2011. Allometric and sexually dimorphic differences between two species of Night-stalking tiger beetle, *Omus audouini* and *O. dejeanii* (Coleoptera: Carabidae: Cicindelinae). Department of Biology, Portland State University, Portland Oregon.

Rivalier, E. 1954. Demembrement du genre *Cicindela* Linne, II. Faune americaine. Revue francaise d'Entomologie 17:217 – 244.

Robbins, K. 2013. *Verbal correspondence to J. Heron.* February 2012. Species At Risk Biologist, B.C. Ministry of Forests, Lands and Resource Operations (Region 2), Surrey, B. C.

Roemer, H. 1972. Forest vegetation and environments on the Saanich Peninsula, Vancouver Island. PhD. Thesis, Department of Biology. University of Victoria, Victoria, British Columbia 292pp.

Salafsky, N., D. Salzer, A.J. Stattersfield, C. Hilton-Taylor, R. Neugarten, S.H.M. Butchart, B. Collen, N. Cox, L.L. Master, S. O'Connor, and D. Wilkie. 2008. A standard lexicon for biodiversity conservation: unified classifications of threats and actions. Conservation Biology 22:897–911.

Tanaka, A. 2012. *Verbal correspondence to J. Heron.* February 2012. Species At Risk Biologist, Canadian Wildlife Service, Environment Canada, Delta, British Columbia.

Teucher, A. 2010 - 2012. *Personal data and Verbal correspondence to J. Heron.* February 2012. Species At Risk Biologist, Canadian Wildlife Service, Environment Canada, Delta, British Columbia.

Thomson, R.E., B.D. Bornhold, and S. Mazzotti. 2008. An examination of the factors affecting relative and absolute sea level in coastal British Columbia. Canadian Technical Report of Hydrography and Ocean Sciences 260. 49pp. http://www.dfo-mpo.gc.ca/Library/335209.pdf [accessed December 3, 2012].

Trombulak, S., and C. Frissell. 2000. Review of ecological effects of roads on terrestrial and aquatic communities. Conservation Biology 14(1):18–30.

van den Berghe, E.P. 1990. On the habits and habitat of Omus (Coleoptera: Cicindelidae). Cicindela 22(4): 61-68.

Ward, P., G. Radcliffe, J. Kirkby, J. Illingworth, and C. Cadrin. 1998. Sensitive Ecosystems Inventory: East Vancouver Island and Gulf Islands 1993-1997. Volume 1: Methodology, Ecological Descriptions and Results. Technical Report Series No. 320, Canadian Wildlife Service, Pacific and Yukon Region, British Columbia. 264 pp.

Wetland Stewardship Partnership. 2007. http://www.greenbylaws.ca/ [accessed October 28, 2012].

WorkBC. 2012. http://www.workbc.ca/Pages/Home.aspx [accessed October 28, 2012].

Zevit, P. 2012. *Verbal correspondence to J. Heron.* October 2012. Biologist, Surrey, British Columbia.

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Jennifer Heron is the provincial invertebrate conservation specialist with the B.C. Ministry of Environment. She directs and manages the provincial approach to invertebrate conservation, including the development and implementation of provincial legislation, policy, procedures, and standards for the conservation, and recovery of invertebrate species at risk, their habitats and ecosystems, and to keep these species from becoming at risk. She works with other invertebrate specialists to develop recovery-planning approaches and assign conservation status ranks to invertebrate groups. She works with local conservation and stewardship groups to achieve common public outreach goals.

COLLECTIONS EXAMINED

The following institutions reported that they have holdings of Audouin's Night-stalking Tiger Beetle specimens (Table 1):

Canadian Museum of Insects, Arachnids and Nematodes [CNC], K.W. Neatby Building, 960 Carling Avenue, Ottawa, Ontario K1A 0C6 (museum records).

California Academy of Sciences [CAS], Entomology Collections, 55 Music Concourse Drive, San Francisco, CA 94118 (museum records).

Royal British Columbia Museum [RBCM], 675 Belleville Street, Victoria, B.C., Canada V8V 1X4 (museum records). (Copley pers. comm. 2012)

Spencer Entomological Collection, Beaty Biodiversity Museum, University of British Columbia, 2212 Main Mall, Vancouver, B.C. Canada V6T 1Z4 (museum records). (Needham pers. comm. 2012).

The following institutions reported that they have no holdings of Audouin's Night-stalking Tiger Beetles:

Canadian Museum of Nature [CMN], PO Box 3443, Station D, Ottawa, Ontario, Canada K1P 6P4.

Royal Ontario Museum [ROM], 100 Queen's Park, Toronto, Ottawa, Ontario, Canada M5S 2G6.